

DOCUMENT RESUME

ED 123 587

CS 002 671

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 TITLE Cognitive Structures in Human Story Comprehension and Memory.
 INSTITUTION Rand Corp., Santa Monica, Calif.
 REPORT NO P-5513
 PUB DATE Sep 75
 NOTE 184p.; Reprint of author's dissertation, Stanford University

EDRS PRICE MF-\$0.83 HC-\$10.03 Plus Postage.
 DESCRIPTORS Association (Psychological); *Cognitive Processes; Comprehension; *Content Reading; Doctoral Theses; *Memory; *Narration; *Reading Comprehension; Recall (Psychological); Short Stories

ABSTRACT

This research examines the effects of structure and content variables on memory and comprehension of prose passages. A process model for the comprehension of stories is proposed which assumes that stories are encoded in a hierarchical organizational framework which represents the abstract structural relationships of the plot. The implications of the model for the quality and characteristics of subjects' memory for stories were tested in a series of experiments using undergraduate college students. The study revealed that: (1) recall of a story was a function of the amount of inherent plot structure in the story; (2) story summarizations from memory tended to emphasize general structural characteristics rather than specific content; (3) structure and content manipulations significantly influenced recall; and (4) false recognition rates for implicit inferences from a story were a function of the plausibility of the inferences and their roles as organizing and integrating devices for other information in the story. (Author/LL)

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COGNITIVE STRUCTURES IN HUMAN STORY
COMPREHENSION AND MEMORY

Perry W. Thorndyke

September 1975

P-5513

CS 002 671

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The Rand Corporation
Santa Monica, California 90406

COGNITIVE STRUCTURES IN HUMAN STORY
COMPREHENSION AND MEMORY

A DISSERTATION
SUBMITTED TO THE DEPARTMENT OF PSYCHOLOGY
AND THE COMMITTEE ON GRADUATE STUDIES
OF STANFORD UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

By
Perry W. Thorndyke
August, 1975

COGNITIVE STRUCTURES IN HUMAN STORY COMPREHENSION AND MEMORY

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Stanford University, 1975

This research examines the effects of structure and content variables in memory and comprehension of prose passages. The passages utilized represent a large class of simple narrative stories containing a setting, main character, problem to be solved, plot sequence, and resolution. A process model for the comprehension of these stories is proposed which assumes that stories are encoded in a hierarchical organizational framework which represents the abstract structural relationships of the plot. The implications of the model for the quality and characteristics of subjects' memory for stories is tested in a series of experiments. In Experiment I, subjects' recall of a story was found to be a function of the amount of inherent plot structure in the story. Experiment II extended these recall results to different materials and structuring conditions. In addition, it was found that story summarizations from memory tended to emphasize general structural characteristics rather than specific content. Experiment III tested the effects of repeated structure and content in successive stories. Both structure and content manipulations significantly influenced recall. Furthermore, repeating story structure across two passages produced facilitation in recall of the second passage; while repeating story content produced proactive interference. In Experiment IV a model for the use of inferences during story comprehension was tested. The general finding was that false recognition rates for implicit inferences from a story was a function of the plausibility of the inferences and their role as organizing and integrating devices for other information in the story.

ACKNOWLEDGEMENTS

Several people have assisted in the preparation of this dissertation. I would like to thank the members of my committee, Gordon Bower, Herb Clark, and Ed Smith, for their support and constructive criticism. I am especially grateful to my advisor, Gordon H. Bower, for his continuing support in numerous ways, some subtle and indefinable, throughout my graduate and adult education. Also, I would like to thank Barbara Hill and Edie Greene for their assistance in testing subjects, scoring protocols, and providing moral support.

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CHAPTER 1

INTRODUCTION

The storage and organization of linguistic information in human long-term memory has been extensively studied by psychologists over the past 50 years. One interesting property of this research is that an inverse relationship exists between the size and complexity of the linguistic unit being studied and the amount of research devoted to that unit. Historically, words and lists of words have received the most frequent usage as stimuli in human memory experiments. Papers by Underwood (1957), Tulving (1962), and Murdock (1962) represent examples of classic paradigms for research in memory for individual words. More recently, a growing amount of research has explored the structural characteristics of sentential and propositional information in memory (e.g., Collins & Quillian, 1969; Anderson & Bower, 1973).

While extensive research has studied human memory for words and sentences, relatively little attention has been given to memory for prose paragraphs or stories. This is true despite the fact that people typically use memory to comprehend or recall anecdotes, stories, or sequences of events with situational structure and context, rather than isolated and unrelated sets of words or sentences. A number of factors have inhibited prose research by cognitive psychologists. Some of these factors are discussed briefly below.

1.1. Constraints in Experimental Methodology

A major roadblock inhibiting prose research lies in the nature of the experimental methodology traditionally used by psychologists. Adopting the scientific method of investigation, researchers design psychological experiments that manipulate one or a few variables of interest within a carefully defined range while holding constant all other variables of the stimuli and experimental context. The measurement of behavioral differences for the various states of the manipulated variable is then assumed to constitute the effect of that variable on behavior.

While this paradigm is well-suited to disciplines such as physics in which universal constants and relationships hold regardless of the experimental manipulations, it presents at least two problems when applied to psycholinguistic experiments in which the dependent variable is human performance. First, human language processing is a composite of a highly complex set of interactive processes. The process of language comprehension often involves the integration of incoming language into the situation or context in which the language occurs (conversation, passage, etc.), the activation and use of previously-learned world knowledge, the generation of inferences from the incoming language, and the generation of expectations about how the incoming information is going to be subsequently used. Since these factors influence the process of comprehension, it is usually desirable to avoid any influence of these variables on performance when characteristics of the stimulus materials are being studied as the independent variables. Researchers have traditionally minimized effects of these processes by selecting simple sets of stimuli (such as word lists or isolated sentences) for which no

context information or reference to world knowledge is available. The use of such "artificial" materials as stimuli allows experimental control over very critical variables such as the saliencies, acquisition histories and contexts, relative frequencies, and recencies of the items whose effects are being investigated. Furthermore, limiting the linguistic complexity of the material and the meaningfulness of the context in which it is presented minimizes the extent to which individual differences in processing strategies will influence experimental results.

The use of artificially-constructed materials, on the other hand, is subject to the criticism that the experimental task and materials are too unlike the types of naturalistic language processing that people normally perform. The danger of using artificial materials is that the nature of the experimental task may have been sufficiently altered from normal comprehension situations that a subject will resort to special processing strategies which are invoked only in the experimental setting and bear little resemblance to "normal" modes of language processing. Hence, there is some question of the generalizability of experimental results to human language processing in general.

1.2. Demands of the Processing Environment

Related to the problem of providing experimental control over subjects in a natural environment is the issue of selection of the processing task itself. A considerable amount of research, primarily by educational psychologists, has demonstrated that learning with prose materials depends on variables influencing subjects' approach to the material. These variables include the task which subjects are required

to perform, their purpose or goal in reading the material, and the constraints of the processing environment (e.g., stimulus exposure time, depth of processing, nature of the required responses, and type of information being sought in the material). Research in this area will be discussed in Chapter 2.

A general conclusion from this research is that behaviors which are important to learning occur at the time a subject reads a prose passage. The processes of encoding the information from the passage in memory are under the control of the reader's goal-directed activities, which arise as a consequence of his exposure to the text. Hence learning is a function of both text characteristics and type of processing activity. Thus it is possible that modifications in task expectations and processing strategies can produce different types and amounts of learning with the same text. In assessing the influence of text characteristics on learning, then, it is critical to exert as much experimental control over subjects' processing expectations as possible while still maintaining a naturalistic task domain.

1.3. Complexity of the Stimulus Environment

A third reason for the relative dearth of research in prose comprehension and memory is the inherent complexity of the structural characteristics of text. While a good deal of research has documented the effects of structure variables in word list and sentence learning, little research has investigated the effects of structure variables in prose learning. This is due primarily to the inability of researchers to agree on how to characterize the structure or content of prose passages. A

partial list of the variables determining the structure and content of a prose passage would include its length, topic, plot structure, concreteness, familiarity of the concepts, and types of semantic relations. While a few researchers have proposed procedures for analyzing the structure or content of a passage, the scope of these procedures has been confined to a specific text, small class of texts, or specific characteristics of the text. The inherent complexity of prose passages makes it difficult to identify and isolate similarities and differences between passages, and hence difficult to construct sets of materials which differ in systematically controlled ways. Furthermore, unless general structure and content variables can be identified, the results obtained from one passage cannot be generalized to other passages.

1.4. The Measurement of Learning

A final problem facing researchers in prose comprehension is how to measure what is learned from a text. In the absence of a comprehensive model of text structure and content, the identification of relationships among concepts stated in the text, the structural organization of the text, and other non-content aspects of the passage is an imprecise enterprise. Several approaches have been taken to the evaluation of comprehension and learning from prose. Many educators have utilized tests consisting of questions about information given in the text to assess learning. In psychology, a number of techniques have been used to measure comprehension and learning, including reaction times (Kintsch, 1974), recognition probabilities (Bransford, Barclay, & Franks, 1972; Sulin & Dooling, 1974), and recall probabilities. The most common method

of assessing what a subject has learned from a passage is to ask for free or serial recall of the passage. The resulting recall protocols are then scored to determine the amount of information recalled from the original text. This method presents the problem of selecting a unit of analysis in scoring protocols. While some researchers have used verbatim recall (using individual words as the unit of analysis) as a scoring technique (Lachman & Dooling, 1968; Dooling & Lachman, 1971; Dooling & Mullet, 1973), this procedure suffers from the weakness that recall of the actual words and surface structures of a passage may be poor even when a great deal of information from the passage is remembered. Furthermore, an analysis sensitive to only individual words cannot account for the complexities and effects of text structure. Other researchers have used larger units of analysis in scoring recall protocols, including phrases or "idea units" (Cofer, 1941; Johnson, 1970), deep structure propositions (Crothers, 1972; Kintsch, 1974; Meyer, 1974), and inferred semantic and conceptual relations (Daves, 1966; Frederiksen, 1975a). The selection of a unit of analysis by researchers usually depends on the small set of properties of the text which are being examined experimentally. These various analytic methods will be discussed in more detail in Chapter 2.

Despite the difficulties, it was the goal of the research described here to identify a domain for the study of language comprehension and memory that could be translated into an experimental setting without massive perturbations on the normal processing requirements on subjects.

Stories¹ were selected as stimulus materials because, for several reasons, they offer a potentially rich domain for analysis:

(1) People typically process language units larger than words or isolated sentences. Studying units the size of stories affords the opportunity to examine the processes and structures people use to comprehend and remember linguistic information presented in real-time in naturalistic contexts.

(2) Stories provide a domain with consistent structural characteristics and constraints, yet potentially limitless demands on people's cognitive apparatus as provided by the structure, complexity, and content of the text. Like sentences, stories have their own internal structure. Although it may not be possible to write a complete grammar specifying all possible story structures, people have a consistent and correct notion of what is structurally "grammatical" or well-formed, and what is not. An advantage, then, of using a large, rich, though structured domain is that it can be controlled and manipulated experimentally without grossly altering the normal processing strategies for language that people use.

(3) Stories contain both structure and content. (These terms will be discussed in Chapter 3). To a great extent, the structure of a story may be characterized apart from its semantic content, so that the two may be manipulated more or less independently. Hence any differential effects on comprehension and memory for stories due to either structure or content may be isolated and independently assessed.

¹A precise definition of the term "story," as it is used in this research, will be presented in Chapter 3.

The research reported here explores the effects of both structure and content variables in stories on comprehension and memory of simple prose "stories." A process model for the comprehension of these stories will be proposed, and the implications of the model for the quality and characteristics of subjects' memory for the stories will be tested in a series of experiments.

CHAPTER 2

BACKGROUND IN PROSE COMPREHENSION AND MEMORY

Most recent research on memory for prose has focused on one of three general areas. The first area examines the influence of the reader's goals and processing activities on comprehension and memory, and emphasizes characteristics of the comprehender during learning. The second area of research has explored the effects of various characteristics of content on memory. The third broad area of research has been devoted to the analysis of prose structure and the attempt to account for learning of a text as a function of various structure variables. These research areas will be considered individually.

2.1. Research on Task Variables

A frequently-studied phenomenon in prose processing is the change in the amount and type of learning which occurs under conditions of instructional variation. A commonly-reported result of such research is that the amount of learning from prose depends on the processing constraints of the task imposed by the experimenter through his learning instructions (Frase, 1969a, 1969b, 1973a, 1975), and the subjects' goal or purpose in reading the material (Frase, 1971, 1973b). The way in which these variables affect subjects' recall of local semantic relations among concepts in a text has been studied by Frederiksen (1975a; 1975b). He presented a text to subjects whose purpose was either to recall the text or to work on solutions to the problems posed by the text in addition to recalling it. Frederiksen found that overall recall of concepts and relations of the two groups was comparable, but that the

group engaged in problem solving produced more inferred concepts and relations in their recalls. Frederiksen's analysis of the concepts and relations in his text dealt only with information expressed as a set of conceptual classes connected by set relations. No attempt was made to consider the inherent narrative structure of the passage, or to study the effects on learning due to altering passage content.

Frase (1975) has argued that it is very difficult, if not impossible, to induce clear-cut learning effects based upon changes in text characteristics. He reported as evidence for this claim a series of experiments in which subjects read at a fixed rate short passages containing descriptions of a fictional country. Embedded in the middle of each passage were three sentences containing either unrelated, class-inclusion, or temporal-relation information. Subjects had been instructed and trained prior to the experiment in evaluating and learning all of the inferences implied by the class-inclusion and temporal-relation sentences. The dependent measure of interest was recall on a sentence completion test of information from the sentences preceding and following the experimentally controlled "target" sentences. In the first experiment Frase obtained a significant interaction between type of "target" sentence and location of the test sentence (preceding or following the target sentences). When the sentence tested preceded the target sentences, there was no difference in recall level. When the test sentence followed the target sentences, recall was 23% better for the independent targets than for the complex relational targets. In another experiment, Frase was unable to replicate these differences. In a third experiment he allowed subjects unlimited reading time and found no

differences in recall. From these data Frase concluded that the amount of information people can learn from a text is unaffected by the characteristics and processing requirements of the text.

Several criticisms of Frase's methodology cast severe doubt on his general conclusions. First, the passages used in Frase's experiment were short descriptive passages containing stative propositions about a single fictional country. There was no narrative event information or plot sequence that required the integration of all information in an organizing superstructure. To a great extent, then, the set of facts presented by the text were somewhat independent, with integration of information being required only to establish continuity in intersentential nominal and pronominal reference. Thus it might reasonably be expected that comprehension of Frase's text would require only minimal trans-sentential integration, and hence not place difficult processing demands on the reader.

Second, the processing required for the "complex relational" sentences was actually quite minimal. Subjects were required only to establish a transitive encoding of three events (related temporally) or concepts (related superordinately). Subjects had been previously instructed on how to draw the required inferences and had received practice trials. Furthermore, the three target sentences always appeared together at the same location in each text, so the subjects could anticipate their occurrence. Thus the relative simplicity of this task makes it doubtful that the processing requirements would severely interfere with comprehending and remembering the other sentences of the passage. This would certainly be expected to be true in the case in which subjects

were allowed unlimited reading time, as was provided in one of Frase's experiments. It seems clear, then, that Frase's general conclusion that learning is unaffected by text characteristics cannot be accepted on the basis of these data.

The research conducted by Frase, Frederiksen, and other educational psychologists is exemplary of an approach to human prose learning that primarily emphasizes the characteristics of the comprehender rather than the characteristics of the text. The justification for this emphasis, as argued by Rothkopf (1972), relies on the observation that the subject's "activities" when studying written text determine to a very important degree the nature of the internal representation of the text. This representation, in turn, determines what is learned. The claim, then, is that the most important source of prediction about learning is the analysis of the subject's activities while he is exposed to the text, and not the analysis of the structure of the text.

It would, of course, be foolish to assert that learning of prose is unaffected by the active processing decisions of the comprehender. However, the denial of any influence of text organization on comprehensibility and learning is an indefensible position for any reasonable definition of "comprehension." In the most general terms, comprehension of linguistic information must involve establishing syntactic and semantic relationships among the linguistic elements in the incoming stream, identifying a context within which the incoming information is consistent, integrating the information into existing memory by creating appropriate memory structures and internal representations, and implicitly evaluating the incoming information on some dimension (truth-validity,

grammaticality, meaningfulness, well-formedness, etc.). It is obvious that many characteristics of text structure will influence the efficiency and success of these processes. A subject will better comprehend a simple 1000-word fairy tale, on any of the criteria of comprehension given above, than he will the same text with the individual words randomly arranged. There is no doubt that the activities of the subject in studying and attempting to comprehend the two texts would be vastly different, and these differences would be due precisely to the different text structures. To attribute most learning differences in prose processing studies to different subject activities rather than to structural differences in the material is to disregard the fact that comprehension consists largely in subjects' attempts to match features of the text structure to prototypical internal representations of knowledge and structure. Insofar as processing activities of subjects are altered with different stimuli, these alterations are often dictated by the structural idiosyncrasies of the material and subjects' attempts to match the perceived structure of the material with a meaningful, integrated representation in memory.

The evidence supporting Rothkopf's position is a set of studies exploring effects of text complexity and readability on learning (Frage, 1975; Rothkopf, 1972; Klare, 1963). The central result of these studies is that sentence complexity and lexical variables such as frequency of use have small effects on what is learned from text by adults when study time is unlimited. However, the conclusion that structural features of text play almost no role in learning does not follow from this result. In fact, Kintsch (1974) has shown that study time is a sensitive depend-

ent measure in the comprehension of texts of varying complexity. By allowing subjects unlimited study time, the experimenter guarantees that comprehension will in fact occur. The actual time required by subjects for study will predictably be shorter for simple texts and longer for complex ones. So, for example, if we allow enough study time, a subject attempting to "comprehend" the 1000-word randomized fairy tale will do so by memorizing the words on the list according to some subjective chunking scheme. On the other hand, subjects learning the 1000-word fairy tale in its normal form will do so by utilizing knowledge of prototypical fairy tales and narrative discourses to encode the various events of the story. To characterize the differences between these tasks solely as a function of the subjects' activities and not as a function of text structure is clearly to misuse the concept of "comprehension."

2.2. Research on Content Variables

Most of the recent research in experimental psychology on memory for prose has characterized subjects' memory for text as a function of content rather than structure. In particular, such research has examined the effects of variables in recall of connected discourse that have been demonstrated to be effective predictors of recall of unrelated word lists. A large number of studies, for example, has demonstrated that the imagery value of a word is an effective predictor of the probability of recall of that word from a prose passage (Yuille & Paivio, 1969; Philipchalk, 1969; Paivio, 1971; Morris & Reid, 1972; DeVilliers, 1974).

Similarly, other researchers have examined the influence of serial position of information on recall of that information from prose.

Significant effects of serial position, particularly primacy effects, have been reported by some researchers (Frase, 1969; Kirscher, 1971; Deese & Kaufman, 1957). However, other researchers have found no effects on recall due to serial position (Richardson & Voss, 1960; DeVilliers, 1974). Meyer and McConkie (1973) provide a reasonable explanation for this contradiction by noting that serial position can easily be confounded with the structural character of a passage. Those passages producing primacy effects in recall are passages in which the important structural ideas are presented in the early sentences. Meyer and McConkie demonstrated that structural importance of the ideas in a passage accounted for most of the effects previously attributed to serial position.

The Meyer and McConkie study points to the critical weakness of much past research in prose memory. Prose differs from word lists not only in syntactic complexity but in its inherent organizational structure dictated by literary conventions of plot, theme, topic, and context. To avoid study of the effect of these factors on prose memory is to ignore the differences between prose and word lists. An adequate accounting of memory for prose cannot ignore the effects of structure in the material on comprehension and recall.

2.3. Research on Structure Variables

Although most investigators studying prose memory have attempted to generalize the results of list learning to prose material, a few have addressed the issue of the influence of prose structure on memory. Virtually all of these studies have discussed structure in a general, non-

specific way, or have used as measures of structure normatively-determined measures of "importance" or "centrality" of specific sentences. One of the earliest studies of memory for prose was reported by Bartlett (1932), who described anecdotally the types of information recalled by subjects from a passage at various intervals of delay. His characterization of recall patterns assumed that remembering involved the reconstruction of ideas in memory from a few details and an organized array of information, or schema. He claimed that new information was assimilated into existing schema and, by and large, lost its particular surface identity. Bartlett used this explanation to account for the inaccurate and distorted nature of the recall protocols he obtained from subjects.

More recent investigators of recall from prose have attempted to elaborate and further specify Bartlett's notions. In so doing, researchers have proposed numerous measures of memory, several terms for describing organizing structure, and virtually no theories of what the structure actually is. Pompi and Lachman (1967) and Lachman and Dooling (1968) presented subjects with stories which were either in their proper order or had the words randomly arranged. On a recognition test, subjects who had received stories in the prose form produced thematic recognition errors. For example, if "cannon" and "general" had been present in the original passage, subjects might false alarm to having seen "rifle" and "colonel." The researchers' conclusion was that the meaning of a discourse is stored as "surrogate structures" consisting of themes, images, or schemata, and that lexical association to this structure may occur during the retrieval of words. Another study (Sulin & Dooling,

1974) demonstrated this intrusion of thematic "ideas" using biographical passages about either a famous or fictitious person (e.g., Adolf Hitler vs. Gerald Martin). It was found that passages with a famous main character produced more false recognitions of sentences that were thematically related to the passage. These results supported Bartlett's original hypothesis that prose passages are stored in schematic form and are assimilated into other knowledge about the theme over time.

Another measure of the effects of prose theme on memory has been recall of individual words (Dooling & Lachman, 1971; Dooling & Mullet, 1973; Lachman & Dooling, 1968). Vague and abstract stories were presented to subjects either with or without the story title. Presentation of the story title provided an organizing theme which enabled subjects to assign the proper referential contexts to concepts in the passage that otherwise seemed obscure. Free recall for words of the story was found to be better when the organizing theme (the title) was given than when it was omitted.

Johnson (1970) divided Bartlett's "War of the Ghosts" story into "linguistic subunits" determined by acceptable pause locations during reading. To determine an index of the importance of an idea to the passage, he had subjects rate the centrality or importance of individual subunits to the larger prose passage. This structural importance measure predicted the probability of recall of the units on a free recall task. That is, units with high structural importance scores were better recalled than those with low scores.

Kintsch (1974) has extensively studied the effects of text characteristics on memory. This research has been primarily concerned with

the development of a formal representation for the meaning of texts which could serve as a basis for psychological experimentation. Kintsch defines the unit of representation, the proposition, as an N -tuple of concepts consisting of a predicate and its $N-1$ arguments. He represents an entire text as an ordered list of propositions composing a connected graph structured solely by means of a repetition rule. According to the theory, the same argument in successive propositions gives continuity to the text base by linking together the propositions with shared arguments. Argument repetition, then, is the only determiner of the underlying representation of text structure.

While Kintsch's representation is adequate for representing very short, simple sets of propositions, it provides no conceptual mechanisms for the representation or integration of the inferential information common to most narrative discourses. In particular, Kintsch's texts contained only descriptive, stative propositions, or a few events temporally ordered according to his structuring rule of argument repetition. Most commonplace narrative discourses contain additional structuring in the plot sequence involving problems facing a character, intent and motivation in actions, and some comparison of event outcomes to the initial problem. Such narrative dependencies among propositions, which are critical elements in the structure of more complex stories, cannot be represented in Kintsch's model.

In addition to arguing for the formal adequacy of his propositional representation, Kintsch attempted to show that his representation predicts experimental data. He reported a number of experiments in which the results are predicted and explained by the model. In one experiment

(Kintsch & Keenan, 1973; Kintsch, 1974, Chapter 6), the reading time for texts of controlled word lengths increased with the number of underlying propositions in the text. In addition, the position of a proposition in the hierarchical representation of the text predicted the probability of recall of that proposition when subjects reproduced the text from memory. The higher propositions in the hierarchy were better recalled than those propositions occurring lower in the hierarchy. In another experiment, Kintsch showed that sentences controlled for number of content words were recalled as a unit better if they were composed of a single underlying proposition than if they were composed of two or three propositions. All of these results were taken as evidence for the psychological reality of the proposition as the unit of analysis.

One difficulty with these experiments is the confounding of structure and content in contrasting sentences in different conditions. When comparisons were made between reading time or recall of sentences of different propositional composition, or between recall of propositions from different locations in the underlying hierarchy, these comparisons were invariably between propositions with entirely different content. For example, Kintsch compared recall of the sentences The policeman issued the driver a summons and The crowded passengers squirmed uncomfortably (Kintsch, 1974, Chapter 7). Kintsch assumed these sentences are in some sense equivalent, because each contains four content words. Kintsch's analysis, however, represents the first sentence as one proposition and the second sentence as three propositions. The fact that the second sentence was recalled less frequently than the first was taken as evidence for the correctness of the proposed underlying representation.

The problem with this analysis is that it is highly questionable whether the two sentences are controlled for all important variables except the underlying number of propositions. The first sentence contains as its content words three nouns and a verb, while the second sentence contains a noun, a verb, an adjective, and an adverb. These content words serve different grammatical functions in the two sentences. In addition, adjectives, verbs, and adverbs tend to be less imagable than nouns and thus probably harder to recall (Paivio, 1971). Furthermore, differences in the imagery value of the verbs (e.g., between issued and squirmed) can have a significant influence on sentence recall (Thorndyke, 1975). Thus, the confounding of these intra-sentence variables with number of underlying propositions seems to render Kintsch's conclusions extremely tenuous.

Another uncontrolled factor in Kintsch's designs is the situational context in which the to-be-recalled sentences appear. Since the sentences are embedded in a coherent text, a critical part of the comprehension process must involve the identification of a situation or context that provides information used in establishing inter-sentential connections. The extent to which a sentence is consistent with or critical in the established or expected context is a factor influencing the memory for that sentence (Bransford & Johnson, 1972). Additional evidence for this fact will be presented in Chapter 8. Kintsch provides no metric for determining inter-sentential relation, except by the argument repetition rule. Even there, Kintsch offers no assurances that his test sentences in different conditions were controlled for types of inter-sentential argument repetition.

In the experiments reported in the following chapters I have attempted to avoid these methodological pitfalls by distinguishing the structure and content of a text. When the effects of varying structure in the material are being tested, the content of the material across conditions is controlled by using the identical surface forms in all conditions. In those cases in which slight alterations in the surface forms were required in order to produce structural changes, the affected words or phrases did not enter into the scoring criteria for recall. Hence measurement of the dependent variable occurs across only those stimuli with identical propositional content in the different conditions. This procedure insured that a pure measure of structural effects could be obtained. In addition, it allowed the independent assessment of the effects of structure and content on memory for stories in a paradigm manipulating both variables orthogonally (see Chapter 7).

In addition to Kintsch, other investigators have used "propositions" as their unit of analysis in prose passages (Daves, 1966; Frederiksen, 1972; Crothers, 1972; Meyer, 1974). Each of these researchers has proposed an elaborate scoring scheme for performing a precise analysis of the conceptual and relational content of propositions recalled in text-learning experiments. While these attempts to analyze prose have recognized the existence of organizational structure in prose and its influence on recall, these analyses are still very content-dependent. That is, the structures into which the prose is analyzed do not depend on any nonlinguistic assumptions about the way prose is organized, but are tailored to accommodate the specific information of a passage. For example, Daves and Frederiksen analyzed their text only for the underlying

class-inclusion relations among the concepts of the passage. Their analysis scheme could not represent characteristics of topicalization or event structure. So, for example, the relationships among concepts as represented in Frederiksen's system would be unaffected by randomizing the order of sentences in the text. While such a randomization would not affect the semantic relationships among the concepts in the text, it would result in a virtually incomprehensible and nonsensical passage. Thus it seems clear that important elements of text structure are ignored by this analysis scheme.

Similarly, the hierarchical representation structures of Crothers (1972), Kintsch (1974), and Meyer (1974) are unable to represent complex structural characteristics of text. The hierarchical nature of the underlying representation comes about merely as a result of subsuming under a concept node sequentially-occurring propositions about that concept. The role of an individual proposition in the text is defined as a function of its topical referent and argument repetition, and not with respect to its function in the general structural framework of the passage. During comprehension, then, the underlying structure is built by simply connecting a new proposition to the hierarchy of previously-comprehended old ones by establishing which concept or argument was repeated in the new proposition. Hence there is no mechanism for the prediction or expectation of future structural elements in the passage on the basis of a known, generalized, context-free structural framework. Such a representation may be adequate for descriptive passages consisting primarily of stative propositions about a topic with few or no event sequences. However, it is inadequate for the identification of implicit

causal relations, underlying goals, and character motivations that are important parts of the comprehension process for narrative stories.

Much of the work attempting to identify general organizational structures in prose has been conducted in linguistics. This work has centered on the examination of the structural composition of folktales. The most influential work in this area was done by Propp (1958), who attempted to identify the morphology of folktales by characterizing functional relationships among the characters. These functional units specify abstract relationships occurring in numerous folktales as sequences of actions but are independent of the particular characters in the folktale. For example, some of the functions occurring in many folktales include Villainy (by an evil force), Departure (by the hero), Struggle (between the hero and the evil force), and Victory (by the hero). These functional relationships are content-free in that they may occur among many different characters in many different stories. According to Propp, these functions constitute the structural components of a folktale, and the number of known functions is limited.

More recent research has continued the attempt to isolate structural components of a story or narrative that are independent of any particular passage (Colby, 1972; Lakoff, 1972; Rumelhart, 1975). This attempt to specify grammars for narratives is analogous to Fillmore's (1968) case analysis for sentences. Each story contains a well-defined set of structural units or roles that are filled by particular characters or actions. One of the goals of the research presented here is to demonstrate that adults have this structure for simple narrative stories stored in memory. Other knowledge may pertain more generally to the

structure of event sequences in a narrative. Insofar as people are able to identify a particular story as an example of a general, learned organizational framework, they use that framework to comprehend and encode the information in a particular story. The research presented here attempts to demonstrate that such general structures are used by people during comprehension and recall of stories as a technique for improving memory. The analysis of structure intentionally bypasses a detailed micro-level analysis of the content of individual propositions. Rather, the purpose of this research is to explore how common features of narrative text organization influence recall of entire propositions and sets of propositions. It is claimed that this approach does not sacrifice analytic power but is merely a consequence of focusing on text macro-structure and organization rather than on relations among individual sentential components.

CHAPTER 3

A REPRESENTATION FOR STORIES IN MEMORY

Whenever a theory of language representation is proposed for some subset of a language, a number of theoretical issues must be addressed. One of the main problems facing the theory is the demonstration of the adequacy and completeness of the proposed formalism as a base for natural language. Whatever the proposed representation, it must be able to encode all the information and knowledge that can be expressed in the surface structure. Using the sentences as the unit of analysis, linguists, computer scientists, and psychologists have explored this problem extensively. The result of this research has been the proliferation of models for language representation utilizing both formal logic (Raphael, 1968; Keenan, 1971; van Dijk, 1973b; Suppes, 1973) and semantic models more or less disregarding formal logic (Quillian, 1968; Rumelhart, Lindsay, & Norman, 1972; Schank, 1972; Winograd, 1972; Anderson & Bower, 1973; Kintsch, 1974). Given the tremendous complexities and subtleties inherent in language, and the vast amount of knowledge required to express the syntactic, semantic, pragmatic, and inferential dependencies of a language, it is clear that no model can achieve complete expressive power. Researchers have circumvented this fact by either severely limiting the knowledge domain spanned by the model (e.g., Quillian, 1968; Winograd, 1972) or by constraining the model to specific types of processing tasks (e.g., Raphael, 1968; Anderson & Bower, 1973).

Consistent with this tradition, the model of story grammar and

comprehension presented here is not intended to be comprehensive or complete. Rather, an attempt will be made to model the structure and content of a particular class of narrative discourses, for which there are numerous commonly-occurring exemplars in many languages. A simple process model for the way in which people make use of the consistencies of story structure during comprehension and memory encoding will be proposed. The model of structure and processing will then form a basis on which predictions can be made for subjects' behavior on a variety of story comprehension and memory tasks. The adequacy of the model will thus be demonstrated in its ability to account for human performance characteristics obtained in relatively naturalistic processing environments. While sidestepping the issue of completeness, then, it is the goal of this research to demonstrate the adequacy of the model in accounting for the processes of comprehending and remembering stories, and to investigate the variables influencing the efficiency of these processes.

A second major challenge faced by researchers in language representation is the translation problem. This problem consists in the specification of the formal procedures that parse surface structures into the encoded representation and/or generate linguistically-correct surface forms from the underlying conceptual structures. A significant amount of work on artificial intelligence has addressed this problem. The number of issues arising in the construction of such a system for story comprehension would in themselves easily occupy an entire thesis effort. While this would be a useful endeavor, it is not the focus of this research and will be circumvented here. Instead, the starting

point has been to assume the existence of these underlying representations and processing strategies, and to demonstrate that people do in fact use the structures and processes to derive the surface structures reconstructively during recall. The evaluation of the correctness of the model of story representation and comprehension, then, will depend not on a demonstrable computer program for simulation of these processes, but rather on the ability of predictions of the model to explain the obtained experimental data.

3.1. Type of Stories

For the purposes of this paper, it will be useful to distinguish among three types of prose passages. These passages vary in the amount and type of structural organization present in or identifiable from the text. These passage types are listed and described below.

DESCRIPTION. A description is a connected discourse consisting of a set of stative propositions or isolated actions that provide a description of a topical concept. The sentences of a description obey the normal conventions for a connected discourse, such as topic continuity and clarity of nominal and pronominal references. The information contained in the passage is essentially a set of facts, presented as one might describe the objects in a painting or explain an abstract concept. That is, the description contains little or no temporal or causal continuity among propositions. For example, the following excerpt is taken from Crothers (1972):

A nebula is any heavenly body which glows and has relatively fixed location in space and looks fuzzy or nebulous. There are two kinds of nebulae. One kind is the nebulae outside our own galaxy. The ones outside our galaxy are composed of stars.

Thus these nebulae are called Galaxy Nebulae.
Galaxy Nebulae appear in clusters of from 2 to
30 galaxies

Researchers have most frequently used passages of this type as stimuli in prose learning experiments. It may be noted that the structure of the description derives exclusively from the successive attribution of properties or statements of single events about the focal concept.

NARRATIVE. A narrative passage is a connected discourse depicting a set of temporally-sequenced events that are related within a unifying context. The sequence of events may describe or imply local causal constraints that interrelate events in the sequence. In addition to sequentially-occurring events, the narrative may contain in the text stative predictions or other descriptive information. The narrative differs from the description, however, in the structure provided by temporal and causal links among events in the passage. The following text is an example of a narrative passage used in a prose comprehension experiment by Kintsch (1974):

A carelessly discarded burning cigarette started a fire. The fire destroyed many acres of virgin forest.

The events described in this narrative are related by temporal and causal relationships which determine their order of occurrence. While the propositions in a description may often be presented in any order while maintaining a coherent and well-structured passage, the temporal and causal structure of a narrative event sequence determines to a great extent the presentation order of the events. Consider the following short narrative taken from Rumelhart (1975):

Margie was holding tightly to the long string on her beautiful balloon. Suddenly, a gust of wind caught it. The wind carried it into a tree. It hit a branch and burst. Margie cried and cried.

The sequence of events in this narrative are fixed by the temporal and causal relations among them. If the sentences of the narrative were reordered randomly the passage would be nonsensical. Thus the structure provided by event sequencing introduces an additional level of structural constraint to narratives which is not provided in descriptions.

STORY. The term story is used here to refer to the class of narrative passages having a simple plot structure in addition to the temporal and causal narrative structure. The plot structure of the stories used here consists of a setting, a goal or problem-solving theme which is stated near the beginning of the passage, an episode sequence which consists of attempts to achieve the goal, and a resolution of the problem. The addition of plot structure to a passage involves the identification of a main character(s), the attribution of intent and motivation to the actions of the main character, and the occurrence of a succession of events revolving around the character's attempt to achieve the goal. The introduction of the elements of problem-solving and actor intent into the story provide an additional level of organizational structure not present in a narrative.

This simple plot framework is exemplified in numerous familiar, real-world situations. For example, the structure of anecdotes, television dramas, cultural folktales, and children's stories all conform to this general framework for plot structure. Several researchers

have provided a detailed specification of the plot structures for various collections of cultural folktales, including Russian folktales (Propp, 1958; Lakoff, 1972), Eskimo folktales (Colby, 1972), and Aesop's Fables (Rumelhart, 1975). However, in contrast to the frequent usage of descriptions as stimuli in prose learning experiments, little attention has been given to the influence of the structural characteristics of stories on comprehension and memory. Bartlett (1932) used a story as the stimulus in his memory experiment, but he characterized his recall data in a non-specific, general manner, and made no attempt to give a detailed structural analysis of the passage. Johnson's (1970) analysis of Bartlett's story identified linguistic, not structural units of the passage. Schank (1974) provided a structural analysis of Bartlett's story that he claimed predicted certain specific features of the recall protocols obtained originally by Bartlett. Rumelhart (1975) has attempted a more general approach to plot analysis in specifying a grammar of stories that he applied in the analysis of several of Aesop's Fables. This analysis forms the basis for a proposed set of summarization rules that allow condensation of the original text into a summary or précis of the original text. The application of these rules to semantic structures generated by the story is claimed to produce summaries corresponding to those provided by subjects summarizing the original story from memory.

One common characteristic of this research with stories is that the effects of structure on memory were observed only with the use of well-structured stories. If the identification and encoding of plot structure is an effective organizational strategy during comprehension,

then it should be possible to disrupt comprehension by altering the structure of the stories in systematic and controlled ways. Experiments I and II consider this hypothesis in detail.

3.2. The Analysis of Structure: Story Grammar

This section outlines a grammar of stories that provides a representational framework for the passages used in Experiments I - III. The grammar is similar, though not identical, to one suggested by Rumelhart (1975). The grammar assumes that stories have several unique parts that are conceptually separable, although in most stories the parts are rarely explicitly partitioned and are usually identified inferentially by the reader. The grammar consists of a set of productions providing the rules of the narrative syntax, and is independent of the linguistic content of the story. The successive application of these productions in generating a representation of a story results in a hierarchical structure that has as intermediate nodes abstract concepts referring to structural elements of the plot and as terminal nodes actual propositions from the story. The rules of the grammar are given in Table 1.

Rule 1 provides the top-level structure for stories. The symbol "+" indicates the combination of elements in sequential order. The requisite components of all stories are Setting, Theme, Plot, and Resolution. The Setting information in simple stories appears at the beginning of the passage. It usually consists of one or a few sentences containing stative propositions establishing the overall context for the story. In addition to introducing the characters, the setting sets

Table 1
Grammar Rules for Simple Stories

<u>Rule Number</u>	<u>Rule</u>
(1)	STORY ---> SETTING + THEME + PLOT + RESOLUTION
(2)	SETTING ---> CHARACTERS + LOCATION + TIME
(3)	THEME ---> (EVENT)* + GOAL
(4)	PLOT ---> EPISODE*
(5)	EPISODE ---> SUBGOAL + ATTEMPT* + OUTCOME
(6)	ATTEMPT ---> { EVENT* EPISODE
(7)	OUTCOME ---> { EVENT* STATE
(8)	RESOLUTION ---> { EVENT STATE
(9)	SUBGOAL } GOAL } ---> DESIRED STATE
(10)	CHARACTERS LOCATION } TIME } ---> STATE

up the global constraints of the story (see Rule 2). These include time context (e.g., 17th century, last week, anytime, timeless), location context (e.g., on an island, "in a far away land," somewhere on the English-speaking part of Earth), and reality assumptions for the story. The reality assumptions for a story are the subset of facts about the universe assumed true in the story. For example, in a science-fiction story, virtually any fact or law may be violated; in a fairy tale, dragons and witches may exist and animals may talk and think. In a newspaper story, the laws of physics and facts in semantic memory are assumed to be true.

The Theme of the story is the general focus to which the subsequent plot adheres. It is often a stated or implied goal for the main character to achieve. Several types of goals may serve as themes for simple stories, including:

- (a) Removal of an obstacle preventing the status quo. For example, after the frog was changed back into a prince, he and the princess lived happily ever after.
- (b) Fulfillment of a desire. For example, the goal of the Old Farmer story (see Appendix Ia) is to get the donkey into the shed. The goal of the Circle Island story (see Appendix II f) is to build a canal across the island.
- (c) Obtaining information or answering a question posed by the story (e.g., who killed the eccentric millionaire?).

The story may often introduce the goal preceded by a sequence of events leading up to and justifying it. This condition is given in Rule 3 of Table 1. The parentheses around EVENT indicate that the element is optional; the asterisk (*) indicates that the element may be repeated. Hence, several events may precede the statement of the goal

during presentation of the theme.

The Plot of the story is an indefinite number of episodes, each of which is a cluster of actions comprising attempts to achieve the goal. The Episode has three components (see Rule 5): a Subgoal, Attempts, and an Outcome. The Subgoal is a particular method of achieving the desired goal. Subgoals are usually not stated explicitly, but they are inferable by the reader from the actions of the main character. The multiple attempts to achieve the subgoal are actions which are either direct attempts at satisfying the subgoal conditions, or involve the creation of additional subgoals (see Rule 6). In the later case an attempt may consist of an entire episode. Thus episodes may be recursively embedded in the plot structure.

The Outcome of an episode is an event or state that results from the attempt to satisfy the subgoal. It is either a success or failure condition. If it is a failure, an additional attempt may occur within the episode, or the main character may submit to failure. If the outcome is a success, the episode is terminated and result of the episode is utilized at the next higher level in the grammar.

The Resolution is the statement of the final result of the story with respect to the theme. For the Old Farmer story, the Resolution is the successful transfer of the donkey into the shed. In the Circle Island story, the Resolution is the imminent revolution of the farmers as a result of their failure to achieve the goal. While the Resolution does not always require a successful attainment of the goal, it does require a response of the main character to the final state of affairs which is consistent with the character's satisfaction with the outcome.

Hence the condition of imminent Civil War is an acceptable Resolution because of the dissatisfaction of the farmers with the failure of the canal project. Figure 1 illustrates the structure of the Circle Island story given in Appendix II f. The numbers in Figure 1 at the terminal nodes of the tree refer to the corresponding propositions numbered in Appendix II f. A proposition is defined here to be a clause or sentence containing an action or stative verb. Relationships between modifiers and their modified terms are not considered as separate propositions unless they appear as relative clauses. A more detailed propositional analysis of semantic relations, such as those utilized by Kintsch (1974), Meyer (1974), Crothers (1972), and others, was not used here because a more macro-level of analysis was sufficient to uniquely specify the structural detail of the stories being studied here. Figures 2 and 3 illustrate the structure of the Old Farmer story given in Appendix Ia. Some of the propositions in Figures 1 - 3 are connected by a horizontal line. This notation designates a single idea or event expressed in two mutually dependent propositions. For example, the goal in Figure 1, represented as propositions 13 and 14 linked together, appear in the passage as The island farmers wanted to build a canal across the island. Other numbered propositions are linked vertically in the network. In these cases the proposition subsumed under a higher proposition expresses an idea or event that is different from its parent but which is a topical elaboration, a further specification, or a causal implication of the information in it. For example, proposition 9 of Figure 1, The governing body is a senate, subsumes proposition 10, whose job is to carry out the will of the majority, because the latter

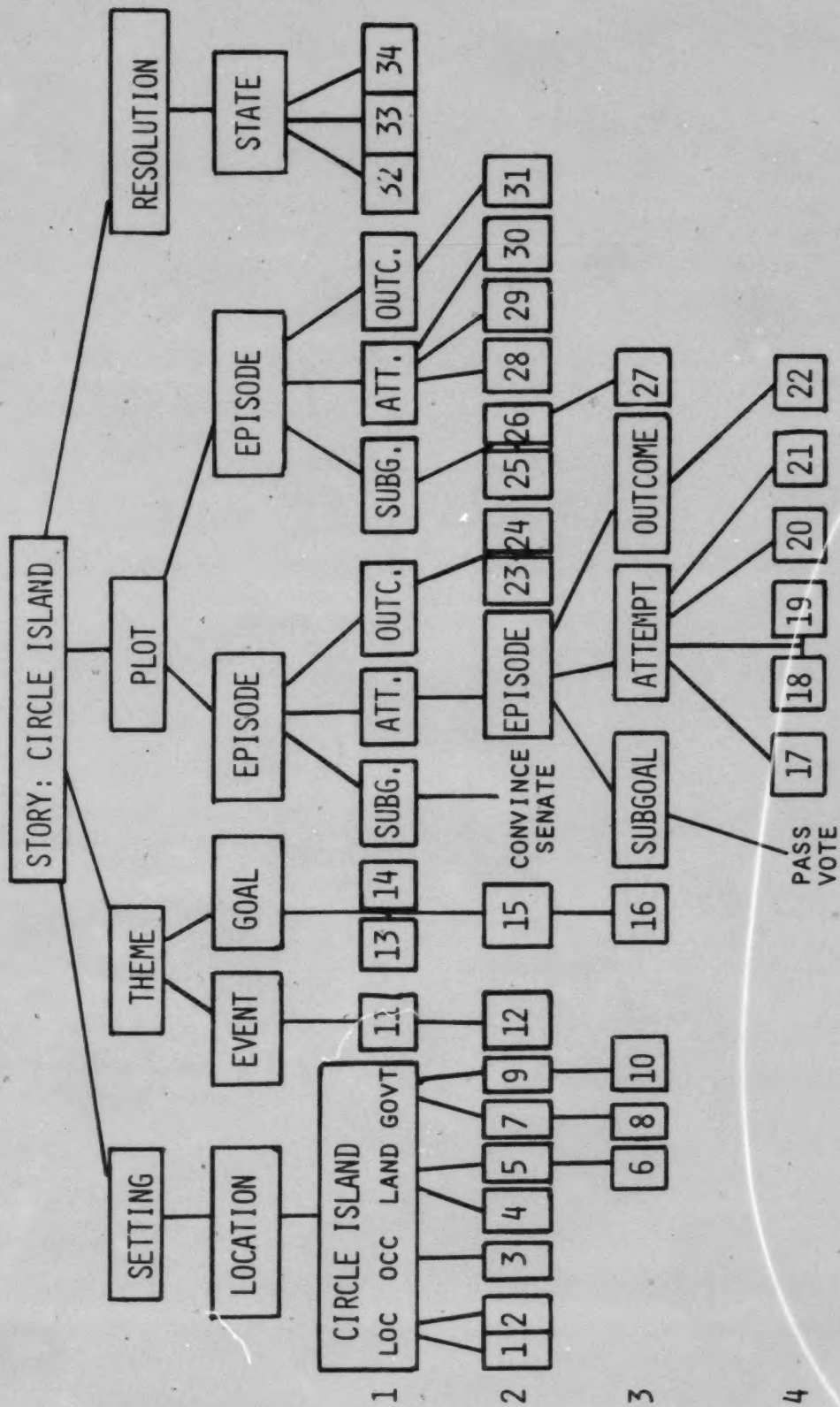


Figure 1. Plot structure for the Circle Island story.

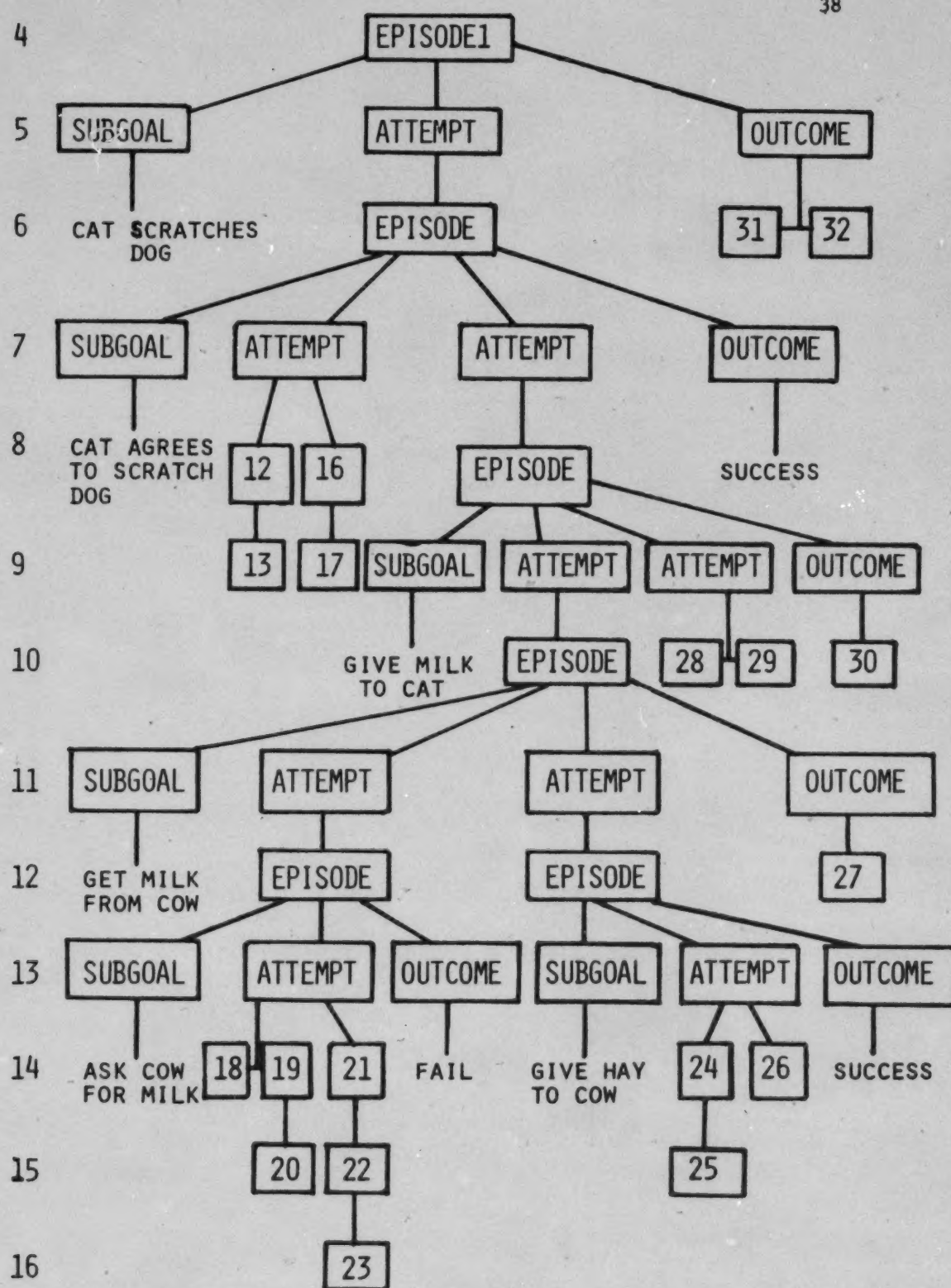


Figure 3. Plot structure for the Old Farmer story (continued).

proposition specifies properties of the concept introduced in the former proposition.

This topical dependency relationship between propositions is similar to that forming the basis of the hierarchical representations of Kintsch (1974) and Meyer (1974). In their work the hierarchy of propositions was obtained solely by means of this topic elaboration or argument repetition scheme. Repetitions of concepts across propositions resulted in the creation of subordinate structures illustrating the dependence of propositions on their topical superordinates. In contrast to this representational scheme, the hierarchies generated here by the application of the grammar to stories specify levels of abstraction in the underlying narrative structure. The intermediate nodes in the hierarchy encode the functional relationships among concepts in the story and how the relationships map into the plot sequence.

3.3. The Representation of Knowledge: Frames

In this section the issue of how encoded stories are represented in memory is considered briefly. It is not the purpose of this paper to propose and defend the details of a particular memory representation for story grammar and discourse knowledge. However, the adoption of an organizing framework will be useful in providing a terminology for the subsequent discussion of structure and process. In addition, the framework will prove useful in explicating the principles of cognitive organization and story processing which will emerge from the experimental data.

A basic observation about people's comprehension of and memory for

stories that will be repeatedly noted is that much of the knowledge they use consists of stereotypical abstractions of concepts and situations. The features associated with a prototypical concept can be altered to fit the characteristics of a particular occurrence of that concept, or they may be used to provide inferred or "default" information about the concept when specific information is missing. This observation forms the basis of a theory for representing knowledge proposed by Minsky (1975). The unit of representation, a frame, is a structure which represents knowledge about a limited domain. A frame for a concept encodes a description of the concept, starting with an invariant structure common to all cases in the domain, and adding specific characteristics according to the unique properties of the particular concept in question. The information provided about a concept by its frame includes a wealth of declarative and procedural knowledge about the concept, including the important structural and semantic properties of the concept, its superordinate concept in a generalization hierarchy, important relations between the frame and other frames, procedures for recognizing the applicability of the frame to particular observations, and procedures for how to use the frame when it is recognized or "instantiated." The theoretical and technical considerations for the incorporation of these mechanisms into a frame representation have been discussed by Minsky (1975) and elaborated by Winograd (1974, 1975) and Kuipers (1975). Rather than attempting a comprehensive application of frame theory to story representation, the following discussion outlines some properties of frames that will be useful in explicating the proposed model of story comprehension. While the resulting oversimplification of frame

theory necessarily overlooks numerous important issues, the discussion sufficiently specifies a representation scheme so as to provide testable hypotheses about memory organization.

The Generalization Hierarchy. Frames are arranged in memory in a generalization hierarchy much like the semantic memory hierarchy proposed by Quillian (1968). Figure 4 illustrates a part of such a hierarchy for prose passages. The hierarchy contains frames for both general concepts (e.g., story, prose-passage) and specific objects (e.g., The Circle Island and Old Farmer stories). Frames are connected by ISA links to their more general or superordinate frames. The primary usefulness of the hierarchy is through the inheritance of properties by frames. Any property true of a frame is implicitly true of any frame linked below it in the hierarchy, unless explicitly contradicted at a lower level. For example, all properties of prose-passages are also true of Circle Island.

The Representation of Important Parts. Each frame represents a description of the concept to which it refers. At the upper levels of the generalization hierarchy, a frame description is representative of a class of objects and the common characteristics of that class. At the bottom of the hierarchy a description applies to a unique object and the properties observed in the specific occurrence of that object. The elements of these descriptions are those properties that are important and central to the identity of the described concept. Each of these important elements, called slots (Minsky, 1975) or IMPS (Winograd, 1975), encodes information which bears a special relation to the frame in which it appears. These IMPS are themselves frames with

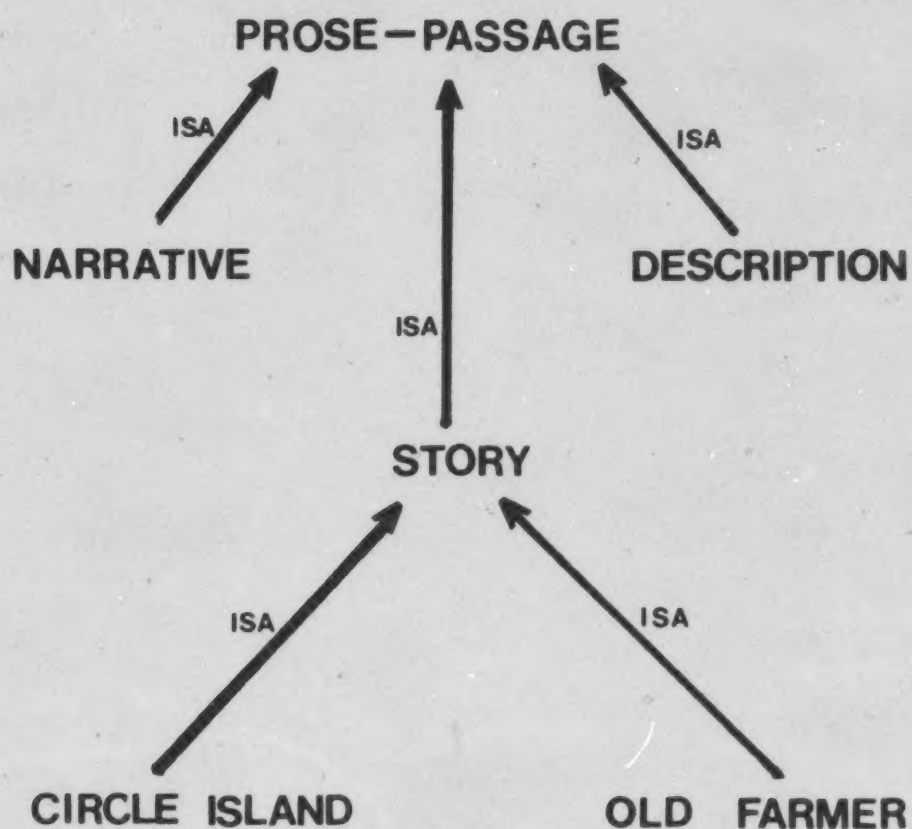


Figure 4. A generalization hierarchy for prose passages.

their own internal structure and important properties. For example, Figure 5 illustrates some partial frames for the representation of the Circle Island story. The two frames at the top, labeled STORY and SETTING, represent the class of stories and settings in the world. Using the type-token distinction of semantic memory models (e.g., Quillian, 1968), these frames are type frames for the general class of concepts to which they refer. The important parts (hereafter referred to as IMPs) of the story frame are Title, Background, Topic, Body and Ending. The fillers for each of these IMPs are descriptions of the information that may be used to specify that property of the frame. The fillers for the STORY IMPs are frames denoted by their frame names. For example, the filler for the Background IMP is SETTING, which is actually a frame of its own (pointed to by its description in the STORY frame). It may be noted from glancing at the STORY and SETTING frames in Figure 5 that the IMPs of a frame serve to encode the structural character of the frame. This means that the grammar for stories can be expressed as a set of frames, with the constituents of a story element represented as IMPs in the frame for that element. Thus the SETTING frame has as its IMPs Time, Location, Characters, and a Sequence Position in the story, which are filled by descriptions providing the semantic constraints on those elements in any story.

Further Specification and Instantiation. A frame becomes further specified by moving down the generalization hierarchy from that frame. When this occurs, the IMPs for the frame also become further specified. Further specification of IMPs occurs as a result of the fact that each IMP is itself a frame with a place in the generalization hierarchy. Hence

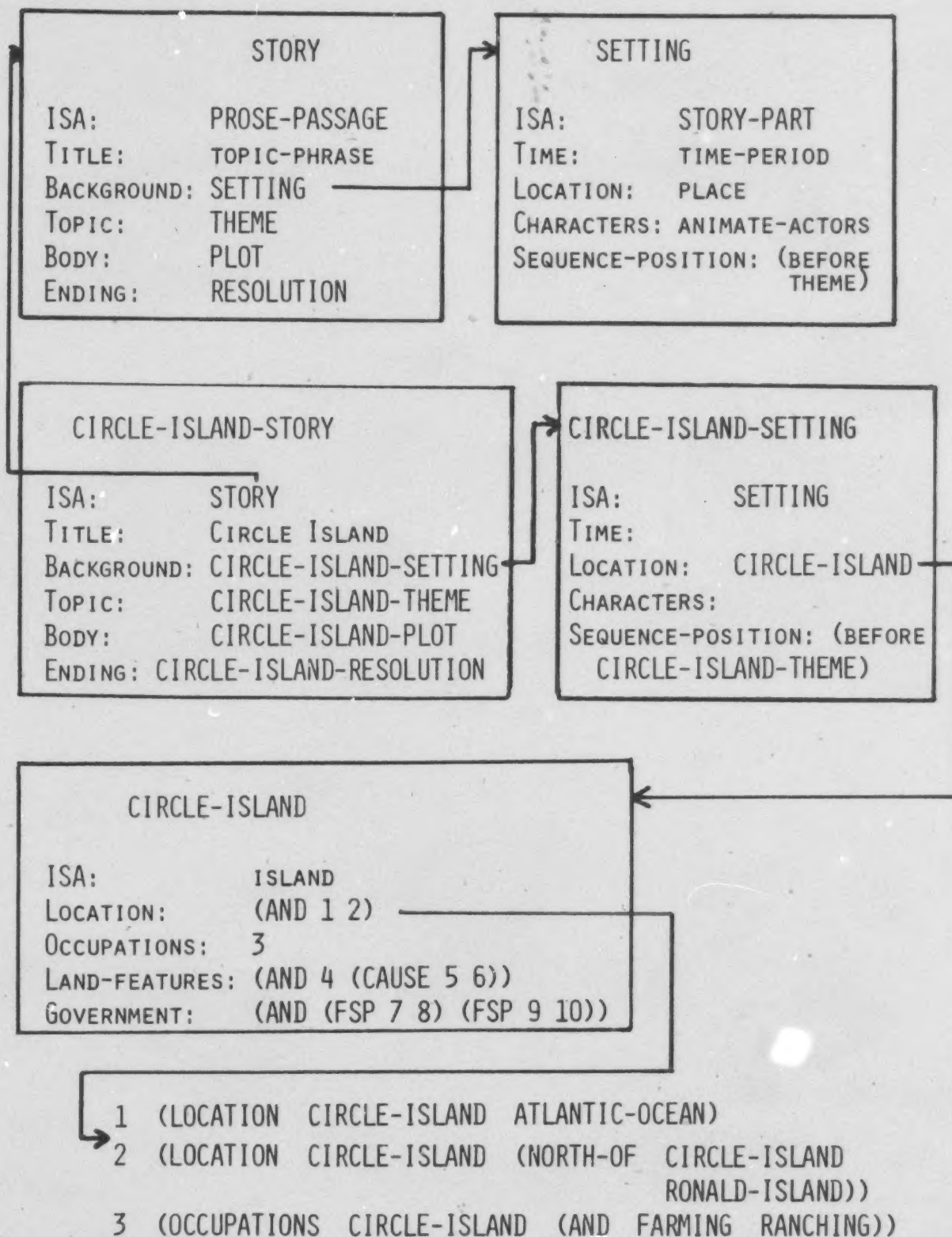


Figure 5. Some frames for representing the Circle Island story.

it too can be specified to a greater or lesser extent. The STORY frame represents a further specification of prose-passages, and thus contains special constraints on the fillers for the Background, Topic, Body, and Ending IMPs.

When a particular concept in the world is being examined, the frame for that general concept produces a description of the concept by substituting real properties of the concept for prototypical ones provided by the frame. This instantiation of a frame is similar to the creation of a token node from a type node in a semantic network. When a particular story is encoded, for example, a frame for that particular story is created in which the default or prototypical structure inherited from the STORY frame is modified to fit the particular characteristics of that story. In this way the general frames encoding the story grammar are used to produce the representation of a particular story conforming to that grammar. Some of the frames from the Circle Island story are given in Figure 5. The frame labeled CIRCLE-ISLAND-STORY encodes the top-level structure of the story and represents an instantiation of the STORY frame. The IMP fillers are the names of frames containing the information specific to the Circle Island story. The Background filler, CIRCLE-ISLAND-SETTING, is pointed to as one such frame. This frame is an instantiation of the SETTING frame, and further specifies the IMPs of the SETTING frame. Location, for example, is further specified from a place in SETTING to Circle Island in CIRCLE-ISLAND-SETTING. The Circle Island frame encodes the information from the first 10 propositions of the story, organized by topic. The actual semantic content of these propositions is represented here in an infix notation

simply for convenience. The numbers of the propositions correspond to those given in Figure 1 and Appendix II f. The level of structure provided in the CIRCLE ISLAND frame closely resembles that specified in the hierarchical propositional models of Kintsch (1974) and Meyer (1974). Propositions are organized with respect to topics (e.g., occupations, land-features, government), semantic relations (AND and CAUSE), and topical subsumption dependencies [e.g., proposition 7 is further specified as (FSP) proposition 8].

Prediction and Inferencing. The generalization hierarchy and instantiation procedure provide a mechanism for prediction in the identification of properties of an observed concept. The predicted description of a prototype frame can be used to guide the collection of observations for IMP instantiation. When features of an observed concept cannot be determined because of missing information, default values for these features are supplied by the prototype frame through the inheritance of properties. In the instantiation of SETTING frame, the IMP filler for Location is specified as a place. Thus the Circle Island frame was created as an instantiation of the Location IMP in the CIRCLE-ISLAND-SETTING frame. Since no potential animate-actors occurred in the first 10 propositions, the Characters IMP is left unfilled except for the possible inheritance of the default value "animate-actors" from the SETTING frame.

These proposed frame structures and processing mechanisms will be useful in explicating the process-model for story comprehension given in Chapter 4. Before presenting this model in detail, however, it will be useful to establish the basic experimental result of the effect of

story structure on comprehension and memory. This demonstration is provided in Experiment I.

CHAPTER 4
EXPERIMENT I

It was noted in Chapter 2 that earlier research has suggested that memory for stories depends on the development of an organizational framework within which to interrelate the events of the story. These organizing frameworks have been variously referred to as schema (Bartlett, 1932; Rumelhart, 1975), surrogate structures (Pompi & Lachman, 1967), theme (Dooling & Lachman, 1971; Dooling & Mullet, 1973), macro-structures (van Dijk, 1973a; Bower, 1974), scripts (Schank & Abelson, 1975), and frames (Minsky, 1975; Winograd, 1974; Winograd, 1975). While these terms have been used operationally in various ways, they all refer generally to the activation and use of structural knowledge about both the world (e.g., causality, temporal sequencing, laws of physics) and about prose passages (e.g., the grammar of plot constructions).

If structural information is used to construct plot frameworks into which particular events of a story are mapped, then the extent to which this information can be used should directly influence subjects' ability to comprehend and remember the story. Although there has been substantial general discussion of the use of structural frames in story comprehension and memory, the effects of systematically varying the amount of structure in a story have not been studied.

The purpose of Experiment I was to assess the effect of varying the degree of plot structure in a story on a person's memory for that story. The term plot structure is used here in the sense in which it

was defined in Chapter 3. It refers to those elements of a story which render the story's sequence of actions coherent and purposeful: the establishment of a theme, goal or purpose of the story, the stated or implied intent and motivation of actions performed by the characters, and some final reference to or resolution of the initial problem of the story. In Experiment I subjects were exposed to a passage which varied in the amount of structural information which was given or inferable from the passage. The number of sentences and the content of the sentences was identical for all passages. In addition, the temporal sequencing, intersentential nominal and pronominal reference, and local causality was not violated for the passages. It was postulated that the ability of a person to remember the events of the story would depend on his ability to map those events into a familiar pattern or plot frame which incorporated information about the goal of the story, the reasons for the actions of the main characters, and causal information relating the various events in the story.

Method

Materials

Four versions of a single story were used in the experiment. The texts of these passages are given in Appendix Ia - Id. The story is an adaptation of an old English fairy tale taken from Rumelhart (1973), entitled "The Old Farmer and his Stubborn Animals." The story concerns a farmer who has as a goal putting his donkey into the shed. In order to accomplish this he creates a subgoal, the achievement of which depends on the attainment of another subgoal, and so on recursively to a

depth of four. The nesting of a series of goals and subgoals provides a well-defined superstructure into which the particular events of the story may be mapped.

The four versions of the story given in Appendix I are identical in content (the number and content of the individual propositions), but differ in the amount of plot structure present in the passage. In the STORY condition (see Appendix Ia), the original story is intact: the theme is presented at the outset, and the plot consists of the subsequent creation and nesting of goals by the farmer in an attempt to satisfy the overall goal. The structure of this story is illustrated in detail in Figures 2 and 3. In the NARRATIVE-AFTER THEME condition the theme of the story was removed from its normal position near the beginning of the passage and inserted as the last proposition of the story (see Appendix Ib). The order of the subsequent events of the story were rearranged so that the implicit goal-subgoal hierarchy could not be inferred by subjects in that condition. Thus the temporal sequencing and local causal constraints remained intact, but the theme-directed plot structure was removed. It was supposed that a subject reading the passage would perceive it as a sequence of unrelated events initiated by the main character, the farmer. At the end of the passage, when the original intent of the farmer is stated, the subject could cognitively reorganize the events of the narrative into the goal-hierarchy suggested by the stated theme. The inability to use this organization at the time of the presentation of the original events, however, should lead to a decrement in the memory for those events relative to the STORY condition, in which the organizing structure was available from

the outset. Thus, although presentation of the theme at the end of the story might allow cognitive reorganization, some of the prior events will have been forgotten due to the inability of the subject to attribute to them a suitable organizational frame.

The third version of the passage, the NARRATIVE-NO THEME condition, was identical to the NARRATIVE-AFTER THEME passage except that the statement of the top-level goal was entirely deleted from the passage (see Appendix Ic). The text of the passage differed from the AFTER THEME passage only in the final proposition.

The fourth passage, the RANDOM condition (see Appendix Id), was constructed by randomly permuting the sentences of the STORY passage. Hence the semantic and syntactic structure of individual sentences was preserved, but any inter-sentence causal and temporal associations were destroyed. As a result, recall of this passage was expected to be equivalent to recall of a list of unrelated sentences. This condition was used to establish a baseline measure of the level of recall for the information in the story in the absence of any structuring strategies.

Subjects

The subjects were 32 undergraduates at Stanford University. They participated in the one-hour experiment either to satisfy a course requirement or for pay. Paid subjects received \$2.00 each.

Design

A between-subject design was used. The single independent variable was passage type and was represented by the following four

conditions: STORY, NARRATIVE-AFTER THEME, NARRATIVE-NO THEME, and RANDOM. Each subject was randomly assigned to one of the four conditions.

Procedure

Each subject was tested individually. An incidental learning procedure was used. A subject was given a printed copy of the passage and was told to read the passage through once slowly and carefully, thinking about the action that took place in the passage. The subject was provided unlimited time to read the passage, but never did the reading time exceed 90 seconds for any condition.

After reading the passage, the subject was told to rate on a 1 (low) to 10 (high) scale the comprehensibility (i.e., clarity and continuity) of the passage using the following guidelines: how well the passage fit together as a coherent whole, and how well the combination of the sentences provided a sensible story.

Following the rating task, an unrelated interpolated task involving memory and comprehension of unrelated sentences was given to the subject. This task was the same for all subjects and had a duration of 40-45 minutes. At the conclusion of this task, the subject was asked to give a written recall of the original passage which he had read at the beginning of the session. He was instructed to write the story as close to verbatim as possible, exactly as it appeared in wording and sentence order. However, he was told not to omit anything which he remembered simply because he could not remember its exact wording or serial position in the passage. Recall was written on a

blank sheet of paper. Unlimited recall time was provided.

Results

For scoring the recall protocols, the passages were segmented into propositions. A proposition was defined as a clause or sentence which contained an action or stative verb. Simple relationships between modifiers and their modified term were not counted as propositions unless they appeared as relative clauses. For example, "There was once an old farmer" was a single proposition; ". . . who owned a very stubborn donkey" was likewise a single proposition. Under this segmentation scheme, each passage contained 35 propositions.

The protocols were scored for gist recall of the propositions, based on a proper reconstruction of the action or relationship given in the propositions. Synonymous paraphrases were permitted, as were deletions of adjective and adverb modifiers. For example, a recall of "A farmer once owned a donkey" would be scored as recall of two propositions. Scoring was performed independently by two scorers using the same scoring constraints. The correlation between the judgments of the two scorers was $r = .93$, and many of the disagreements were errors in scoring, not disagreements in judgment.

The results are shown in Figure 6. Results for subjects' ratings were consistent with the pre-experimental intuitions about the degree of structure provided by the four passages. The mean rating for the STORY passage was 9.5. The rating for the NARRATIVE-AFTER THEME passage (6.1) was slightly higher than for the NARRATIVE-NO THEME passage (5.0). The comprehensibility judgment for the RANDOM passage was

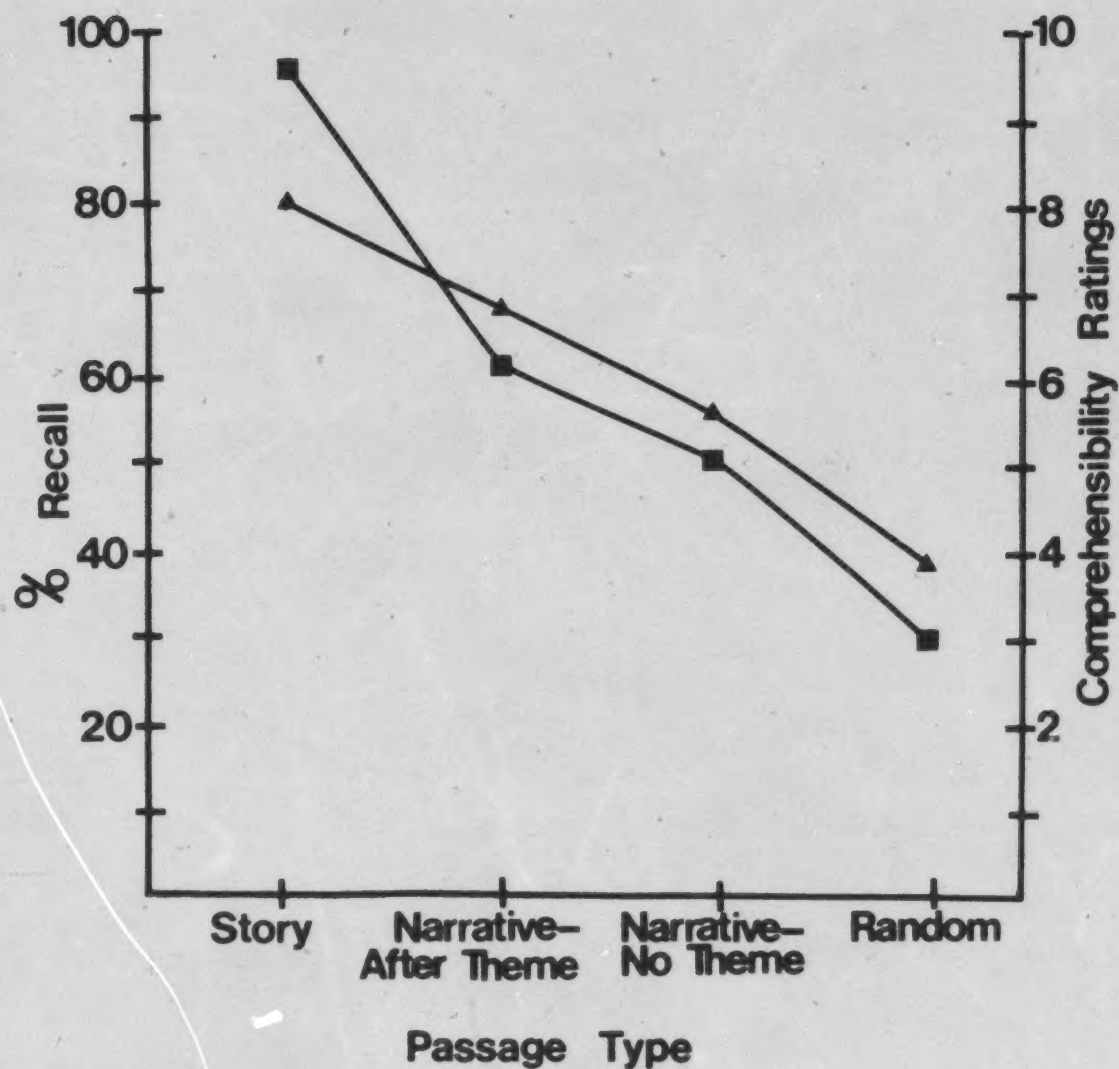


Figure 6. Mean recall probabilities and comprehensibility ratings for the passages of Experiment I.

lowest at 3.0. These differences are reliable, $F(3,28) = 14.31$, $p < .01$. Newman-Keuls tests declared all pairs of means to be reliably different ($p < .05$).

The recall results were consonant with the comprehensibility ratings. Mean recall decreased monotonically with decreasing amount of structure. Recall was best for the STORY passage (80%), followed by AFTER THEME (68%), NO THEME (56%), and RANDOM (38%). These differences were significant, $F(3,28) = 8.22$, $p < .01$. In addition, the differences between all pairs of recall means were significant ($p < .05$). It may be noted that there is a high degree of consistency between the mean comprehensibility ratings and recall levels. The correlation between a subject's comprehensibility rating and his proportion of propositions recalled from the passage was computed across all subjects. The obtained correlation between these two sets of scores was significant, $r = .87$, $t(30) = 9.73$, $p < .001$.

Discussion

From these recall results, it seems clear that memory for a prose passage depends critically upon the amount of identifiable organizational structure in the material. For the STORY passage, the plot structure (apart from the actual content of the passage) is presumed to be an example of a plot familiar to all adults with a history of fairy tale reading. It is clear that most people have heard, if not the "Old Farmer" story, one identical in its nesting of goals and sub-goals presented to the main character. When the STORY passage is presented to a subject, he activates his general frame for "stories,"

creates a new instance or token of this frame for the particular story being presented, and attempts to map incoming propositions from the story into the IMPs of this newly created frame. The IMPs represent the various structural elements of the story which are dictated by the general story frame. For example, in Figure 5 it may be noted that the top-level frame for STORY expects to observe in the story elements of Setting, Theme, Plot, and Resolution. Each of these IMP fillers is itself a frame, which is broken down into its structural units, thus producing the structural hierarchy for the story. The process of reading and understanding the story in real-time, then, consists of the attempt to match frames being created for incoming propositions to the general structural frames for the various story parts. These processes and story-part frames are held in short-term memory or some active processing buffer such that either these match attempts are done on the fly or can be activated very rapidly if required. This is done because tentative matches are required in order to "understand" what the story is about and where it is leading. When an incoming story matches up readily with a standard, well-learned frame hierarchy for story structure, the details of the particular story can be easily plugged into the general structural framework and comprehension of and memory for the story will be enhanced. The result of this process is the encoding of the Old Farmer story according to the structural grammar rules for well-formed stories. This resulting structure in memory is represented in Figures 2 and 3.

When asked for recall, then, the subject retrieves the most general frame which has been instantiated for the Old Farmer story. This

is a frame which corresponds to the one labeled CIRCLE-ISLAND-STORY in Figure 5. This frame is the instantiation of the general STORY frame for the Old Farmer story, with pointers to the frames which encode the information in each of the story's structural components. The subject then begins to unpack the frame's structural elements, searching through a series of frames representing successively further specified information, and eventually retrieving the particular propositions from the original text of the passage. If a particular proposition is not above the threshold for recall, the structure in which it is embedded provides enough predictive power via its specification constraints that a good guess may be attempted. Hence the structural framework serves as a network of retrieval cues for the particular propositions from the story. Insofar as the set of general frames for a story being utilized is well-learned, this mechanism provides a powerful organizing device and memory aid.

In the case in which a NARRATIVE passage is presented, the only structure which may be effectively utilized is one in which juxtaposed events are temporally and sequentially chained together in a linear order. For example, the narrative might include the following (condensed):

The farmer went to his dog and asked the dog to bark. But the dog refused. Then the farmer asked his cow for some milk. But the cow replied that he would rather have some hay. So the farmer went to his cat

The events are sequentially ordered in a coherent and continuous fashion, but there is no identifiable goal superstructure, nor motivation or intent attributable to the farmer. Thus the propositions may be

connected only by local causal links (e.g., ". . . the barking so frightened the donkey that it jumped immediately into its shed") or temporal links (e.g., "But the dog refused. Then the farmer asked his cow for some milk . . ."). This organizational strategy is weaker because the inability to identify goals and attribute intent to the actions of the farmer prohibits the use of a predictive goal-directed frame structure like the one illustrated in Figures 2 and 3. The resulting organizational strategy of simple temporal chaining is weaker than a hierarchical plot structure because it does not provide the structural constraints for predictively inferring information on the basis of a general organizational scheme. Thus it would be expected that lower recall for the narrative conditions would be obtained. This is precisely the result of Experiment I, in which the mean recall for the NARRATIVE-NO THEME passage is 24% lower than for the STORY passage.

For subjects in the NARRATIVE-AFTER THEME condition, the same structuring difficulties encountered in the NO THEME condition are present, except that the last proposition of the story presents the theme or goal. Insofar as the subjects in this condition still have available to them the preceding propositions in the passage, they may go back and reorganize the events of the story into the newly-revealed goal structure. This would not only render the story more comprehensible, but provide a more stable and redundant structure from which to subsequently recall the passage. If subjects do in fact attempt this reorganization, then several experimentally observable results would be predicted. First, rated comprehensibility of the passage should be higher than the NO THEME condition, despite the fact that the two

passages are identical except for the final proposition. This in fact is the case: mean rated comprehensibility of the AFTER THEME passage was significantly higher than for the NO THEME passage. Furthermore, it would be expected that reorganization would lead to improved recall over the NO THEME passage. This prediction, too, was verified: mean recall for the AFTER THEME passage was significantly higher, by 12%, than for the NO THEME passage. This result contradicts the findings of Dooling and Mullet (1973), who found that the presentation of the "theme" of the story at the conclusion of the passage did not improve free recall of individual words from the passage over a group who received no theme at all. However, the present study differs from Dooling and Mullet in that the passage in the AFTER THEME condition still maintained clear temporal sequencing and referential transparency. The passages of Dooling and Mullet were nearly incomprehensible in the absence of a theme. Thus it may well be imagined that if this theme were not present during presentation of the passage virtually no structural integration could be performed, hence most of the propositional information would be lost by the time the theme was finally presented.

If reorganization into a plot structure did occur in the present study, it might be expected that this reorganization would be reflected in the recall protocol. In particular, the theme of the story, the farmer's desire to get the donkey into the shed, might be recalled at the beginning of the story where it would normally appear in a standard story frame. This result might be expected despite the fact that in the original AFTER THEME passage the goal appeared as the final proposition of the passage, and despite the explicit instructions to

subjects to recall the passage in precisely the same order as the original presentation. This prediction was in fact verified: 75% of the subjects in the AFTER THEME condition inserted a proposition of the form "the farmer tried to get his donkey into the shed" near the beginning of the protocol after recall of the SETTING propositions. By contrast, none of the NO THEME subjects intruded a theme or goal into any location of the recall protocols. These intrusion data provide strong evidence for the claim that the AFTER THEME passage produced attempted structural reorganization on the part of subjects receiving that passage.

The results obtained in Experiment I demonstrate the importance of the use of well-learned, generalized memory structures in the comprehension of and memory for a simple story. Combining the structuring assumptions of the model for story presentation presented in Chapter 3 with the data obtained in Experiment I, a simple processing model may now be proposed for the comprehension of stories. A number of properties of the model arise as a consequence of the assumed story grammar and data structures encoding story information. The fundamental properties of the processing model are discussed below.

Hierarchical organization of information. Processing of stories during comprehension is guided by the nature of the stored data structures encoding the story grammar. The hierarchical organization of structural information specifies the syntax of plot constructions. The top levels represent the general, structural elements of a story, and the lower levels represent specific event and state-recognizing frames.

Comprehension by prototype recognition. The process of comprehension of a story consists in the attempt to match incoming data (information from the story) to prototypical descriptions of a story stored in memory. The constraints of prototypicality are provided by the story grammar, which specifies the allowed combinations of structural relations among the events of the story. During comprehension, active processes attempt to match frames encoding generalized relations to the specific incoming propositions of the passage. These processes and story-part frames are held in short-term memory so that either these match attempts may be done on the fly or can be activated very rapidly if required. Successful matches consist in the instantiation of a general story frame with specific frame-filling information from the passage. Successful frame recognition and instantiation facilitates comprehension by providing default specifications for missing information and by allowing the chunking and integration of information into familiar well-learned structures in long-term memory.

Top-down and Bottom-up processing. The processing system can be driven either conceptually or by data. This general property of memory processing systems has been discussed by Bobrow and Norman (1975). Conceptually-driven processing refers to goal-directed attempts to match the incoming information to general structural frames by fitting inputs to expectations. The selection of frames for tentative match attempts at any point in the passage is heuristically guided by predictions provided by the story grammar. When the structure of incoming information does not conform to predictions, processing proceeds bottom-up, by identifying low-level structural descriptions in which

to fit the input. These input descriptions are then evaluated in a number of potential contexts of interpretation as an attempt at structural integration. Thus structural organization can (and does) occur during the comprehension process even when the input material is unorganized. Evidence for this was obtained in Experiment I, in which rearranged events in the recall protocols for the NARRATIVE-AFTER THEME passage reflected subjects' attempts at structural reorganization.

The attempt to process stories in a conceptually-driven, top-down manner has implications for comprehension and learning. The comprehensibility of a story and level of recall of the story from memory should be a function of the ease with which the mapping of propositions of the story onto the general structural frames can be performed and the extent to which processing expectations are met. This result was in fact obtained in Experiment I, in which both comprehensibility ratings and recall proportions decreased as the amount of structure in the passage decreased.

A story that has been successfully comprehended according to a top-down processing strategy is represented in memory in a hierarchical structure such as the one shown in Figure 1. At the terminal nodes of the structure are the actual propositions from the passage. The propositions appear at different levels in the hierarchy according to the number of intermediate frames occurring between the proposition and the top-level STORY frame. It may be noted that the higher in the hierarchy a proposition appears, the more general the structural element of the passage it represents. For example, propositions 13 and 14 of Figure 1 refer to the text "The farmers wanted to build a canal

across the island." This corresponds to the overall goal of the story, a critical structural element on which subsequent story events depend. The level at which these propositions appear is the highest point in the hierarchy containing terminal frames. This level is designated as Level 1 (level numbers are given on the left side of Figure 1). Propositions 17 - 19 refer to the text "The farmers formed a pro-canal association and persuaded a few Senators to join." These propositions represent actions corresponding to an attempt to achieve an embedded subgoal and appear at Level 4 in the structural hierarchy. They are, then, less structurally "central" than propositions 13 and 14.

Several predictions concerning the recall of propositions from a passage may be made on the basis of the process-model for comprehension. Passages conforming to the prototypical story structure will be comprehended and recalled in top-down fashion. Structurally disorganized passages will not be encoded in the hierarchical representation. Thus, for organized passages, it would be expected that probability of recall of a proposition should be a function of its location in the hierarchy. That is, the higher a proposition appears in the hierarchy, the more structurally central it is, and hence the greater its probability of recall. Furthermore, if a subject is asked to summarize a passage from memory, he will select for inclusion in the summary those propositions which are structurally central to the passage. Thus the content of story summarizations should be directly predictable from the organizational structure: propositions near the top of the hierarchy will be included in summaries with high probability, while propositions lower in the hierarchy will be included with a much lower probability.

When the presented passage is structurally disorganized, as in the RANDOM condition of Experiment I, the subject is unable to form the hierarchical representation for the passage structure. Thus recall probability of a proposition in this condition should be independent of its structural centrality. These predictions were tested in Experiment II.

CHAPTER 5

EXPERIMENT II

In Experiment I it was demonstrated that the amount of organizational structure in a passage was a critical factor in subjects' ability to comprehend and recall the passage. This result held despite controlling the number and content of sentences for all passage types. However, the manipulation of structure in the passages of Experiment I was not performed purely on the basis of plot organization. In the RANDOM passage the same implicit organizational cues in the material were present as in the STORY passage; indeed, the RANDOM passage sentences were identical to the STORY sentences, with only the sentence presentation order being altered. Thus the structuring conventions which were absent from the RANDOM passage were not those of plot organization, but rather those of topic signaling and inter-sentential reference. It was desirable to manipulate plot structure as an organizational variable independent of local linguistic constraints such as pronominal reference, topic signaling, and the Given-New contrast (Haviland & Clark, 1974). Experiment II was designed to manipulate amount of plot structure and sentence order orthogonally.

A fourth passage type, the DESCRIPTION, was constructed to accompany the STORY, NARRATIVE-AFTER THEME, and NARRATIVE-NO THEME conditions. In the DESCRIPTION passage, the content of the text was presented without benefit of temporal sequencing or local causal implications. At the same time, however, the linguistic conventions mentioned above for connected discourse were observed, to eliminate any possible referential ambiguity or confusion. The information in the passage was

described as one might describe the objects in a painting, as a set of stative propositions or single actions, with no temporal or causal connection. While the meaning of each individual proposition and sentence would now be clear to subjects, there would be no reference to an organizational frame in which to encode the sequence of statements. Thus it was expected that performance in this condition would reduce to the learning of a set of unrelated propositions or sentences, with order of occurrence or presentation being an unimportant factor.

In addition to the manipulation of structure in the four passages, the order of sentence presentation was orthogonally varied. Each passage type could be presented in either normal sentence order or randomly-arranged sentence order. Since randomization of sentence order eliminates the associational cues of temporal and causal sequencing, it was expected that the contrast in recall between normal and randomly ordered passages would be the greatest for passages containing these organizational cues initially. Specifically, the more organization implicitly contained in a passage, the greater the expected decrement in recall for the randomly-ordered version of the passage. For the DESCRIPTION passage, this difference would be expected to be small or nonexistent. Since this condition held inter-sentential associational and organizational cues to a minimum, there would be no expected decrement in organizational ability for the randomized passage, and hence no expected decline in subjects' recall of the passage.

If implicit organizational structures are used by subjects to comprehend and remember passages, then it would be of interest to determine the precise nature of the organizational structures. The

assumption here has been that the structures subjects use correspond to the theoretical plot structure given in Chapter 4 for stories of this type. This assumption should be experimentally testable by determining what, in addition to how much, subjects remember from a passage. To the extent that a single unique plot frame is utilized by all subjects in the STORY condition, the pattern of propositional recall by those subjects should be highly correlated. In particular, propositions which may be identified as close to the top of the organizational hierarchy are those propositions which correspond to key structural elements of the story plot (e.g., the statements of the goal and resolution). The probability that these propositions would appear in the recall protocol would be expected to be quite high for all subjects. Similarly, those propositions which appeared low in the hierarchical plot structure correspond to less central information: irrelevant detail, instrumental actions, or events unrelated to the resolution of the theme. It would be expected that propositions of this type would tend to be forgotten and hence missing from the recall protocols. These predictions may be tested by computing across subjects the per cent recall of each proposition in the passage of a given type, and then plotting the recall probabilities as a function of theoretically determined centrality of the proposition. Kintsch (1974) and Meyer (1974) have used this procedure in studying simple propositional relationships in prose texts.

Several experimental tasks were devised to identify the organizational frames subjects used and to test the process model for comprehension. In one task subjects produced from memory a concise summarization of a passage they had seen previously. Two dependent variables

were of interest in this task: length of the summarization and stereotypy of the summarization protocol. It was expected that subjects summarizing the more structured passages would produce concise summaries including the propositions corresponding to the key structural elements of the passage. Thus summaries should be short and show a high degree of consistency in propositional content. For the less structured passages and randomly ordered passages it would be expected that summaries would be more verbose, rambling, and would fail to cluster around a few key propositions. When no structure could be identified in a passage, a summary might be expected to consist of a subset of propositions randomly sampled from the original passage. Furthermore, it would be of interest to note whether summaries of passages with random sentence orders would involve a reordering of the selected events, converging on the order present in the normally-ordered passages.

As an attempt to determine the nature of the stored propositions from a passage and the structural relations between propositions, a recognition test was included in Experiment II. The data of primary interest in this task were the false alarm rates for different distractor types as a function of passage type. Different classes of distractors were defined and test items constructed with the purpose of testing specific hypotheses about the way clusters of events are organized in memory, and the way in which memory for events and propositions degrades.

One further manipulation distinguished Experiment II from Experiment I. It was of interest to determine if presentation modality would influence the level of passage recall. As a result, two presentation

modes, auditory and visual, were used. Auditory presentation was accomplished by playing a taped recording of the appropriate passage. Visual presentation was effected with the use of an overhead projector, with the stimuli projected onto a blank wall.

Method

Materials

To minimize STORY-specific effects in the experiment, two unrelated passages were used as stimulus materials. One passage was the "Old Farmer and his Stubborn Animals." The STORY, NARRATIVE-AFTER THEME, and NARRATIVE-NO THEME versions of the story were identical to those used in Experiment I (see Appendix Ia - Ic). The structural analysis of the STORY version of this passage is shown in Figures 2 and 3. A DESCRIPTION version of this passage was constructed according to the constraints discussed above (see Appendix IIa). In addition, a version of each of these four passages was constructed by randomly permuting the sentences of each passage (see Appendix IIb - IIe). To maintain the close similarity of the NO-THEME and AFTER-THEME conditions, the same random order was used for the permuted versions of those two passages.

The second passage used in Experiment II, entitled "Circle Island," was a shortened and slightly modified version of a passage used in earlier memory experiments by Dawes (1964, 1966) and Frederiksen (1972). Eight versions of this passage were constructed, one for each passage type and presentation order condition (see Appendix II f - II m). The structural analysis for the STORY version is shown in Figure 1.

Subjects

The subjects were 64 undergraduates at Stanford University. They participated in the one-hour experiment either to satisfy a course requirement or for \$2.00 pay.

Design

A 4 X 2 X 2 between-subject design was used. There were four conditions of passage type: STORY, NARRATIVE-AFTER THEME, NARRATIVE-NO THEME, and DESCRIPTION. Presentation order was either Normal or Random. Presentation mode was either visual or auditory. Within each condition, both passages ("Old Farmer" and "Circle Island") were used. Each subject was randomly assigned to one of the 16 conditions.

Procedure

Recall task. Subjects were tested in groups varying in size from one to four people. Intentional learning instructions were given. Subjects were instructed to attend to the passages because they would be asked to recall them later. The passages were presented either visually or auditorially. If audio presentation was used, subjects heard a passage read at slightly slower than normal reading rate. Care was taken not to carry inflections or intonations across sentential boundaries to suggest temporal or causal connections between sentences. If visual presentation was used, the passage was projected on a blank wall in front of the subject. One line was visible at a given exposure for five seconds. Lines of the passage were equated for word length. The exposure time per line was computed such that the overall presentation time for audio and visual presentations were identical. Visual

presentation was accomplished by moving a mask down the passage such that only one line was exposed for a given five second interval. After a passage had been presented, subjects performed a comprehensibility rating identical to those obtained in Experiment I. Subjects then immediately wrote a verbatim recall of the passage. Recall instructions identical to those of Experiment I were provided. After recall was completed, the entire procedure was repeated with the second passage. The order of presentation of the two passages was counterbalanced across subjects.

Summarization task. After the second passage had been presented and recalled, subjects were asked to write from memory a short summary of each of the passages, in the order in which they had been presented. They were informed that the summary should include what they considered to be the high points or important parts of the passage. No constraints as to the length of the summaries were imposed or suggested by the Experimenter. Writing time was unlimited.

Recognition test. After both summarizations had been written, a recognition test was given for sentences from the passages. The test included two parts: the first part contained only items about the first passage, the second part items about the second passage. For each test item, subjects were required to give a two-part response. They first judged whether the exact sentence presented appeared in the passage they received. If their response was negative, they then judged whether, although not stated explicitly, the sentence was a true inference that could be drawn from the information given only in the story. (For example, "The old farmer owned some mammals" was not stated

explicitly in the farmer story, but was a true inference about the information in the story.)

Results

Comprehensibility and Recall

The mean comprehensibility ratings for the various passages is shown in Figure 7. For the normal presentation orders, it may be noted that mean comprehensibility ratings decrease monotonically as structure in the material decreases. Insofar as subjects' comprehensibility ratings may be considered a metric of perceived amount of structure in the material, this result supports the theoretical assumption that the ordinal progression from STORY to DESCRIPTION passages was one of decreasing plot structure. For the random presentation orders, there are virtually no differences among the mean ratings, with the exception of the DESCRIPTION-RANDOM condition, which is higher and nearly equal to the DESCRIPTION-NORMAL rating. Overall, the effect of structure on rated comprehensibility was reliable, $F(3,48) = 2.85$, $p < .05$. The obtained differences between Normal and Random presentation orders were highly reliable, $F(1,48) = 57.07$, $p < .001$. As expected, the interaction between structure and presentation order was significant, $F(3,48) = 3.98$, $p < .02$. Newman-Keuls tests were used to test the reliability of pairwise differences between means. For the normal presentation order, the obtained differences among the four structure conditions were significant ($p < .05$ for all three pairwise comparisons). For the random presentation order, the means for the STORY, NARRATIVE-AFTER, THEME, and NARRATIVE-NO THEME passages did not differ reliably. The mean for the DESCRIPTION passage did not differ reliably

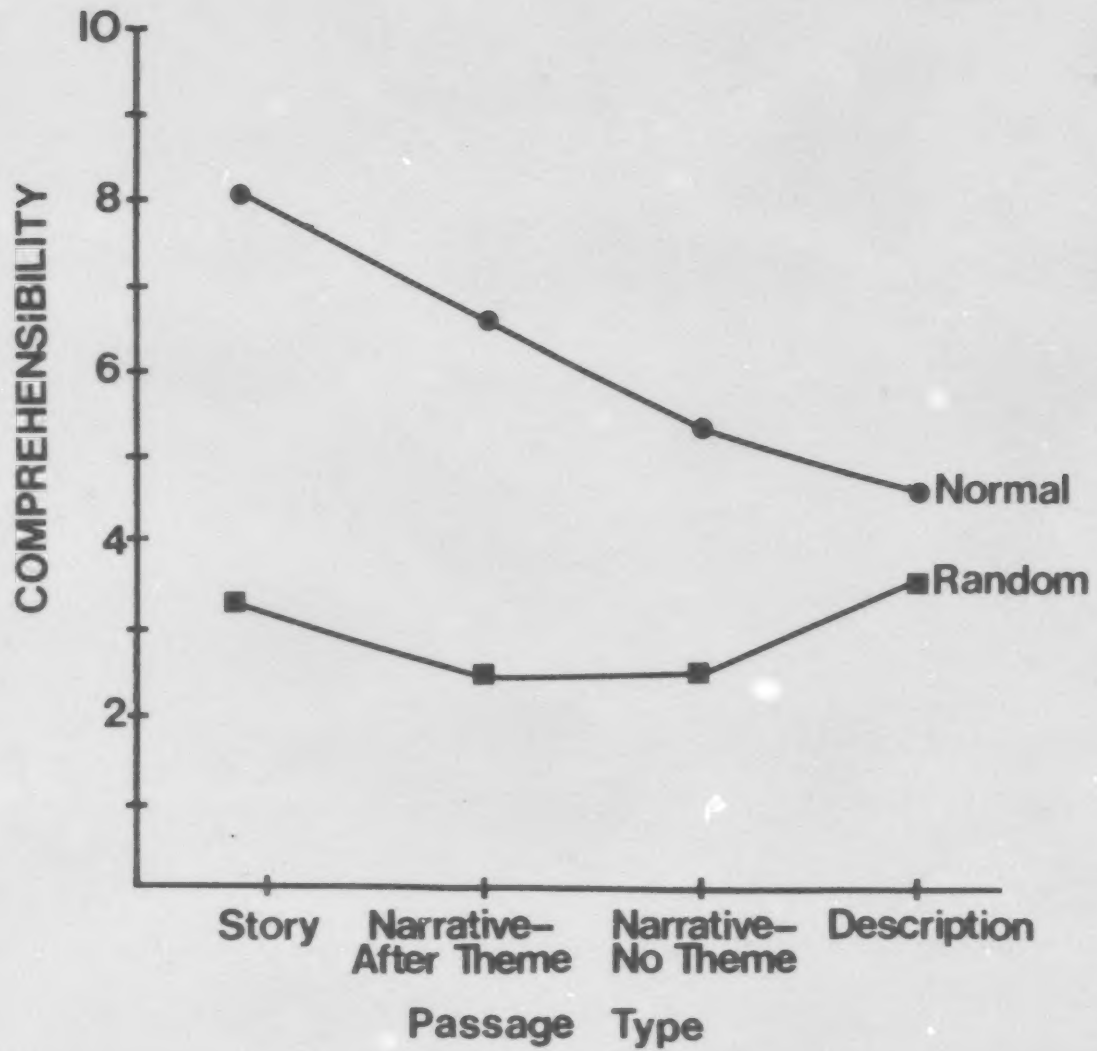


Figure 7. Mean comprehensibility ratings in Experiment II.

from the DESCRIPTION-Normal passage or the STORY-Random passage, but did differ from the two NARRATIVE passages ($p < .05$ for both).

In Figure 8 the comprehensibility ratings are divided for the individual stories. The differences among structure conditions and presentation orders are maintained. However, the ratings for the Old Farmer passages are consistently higher than for the Circle Island passages in the structured conditions. The overall differences due to passages (Old Farmer or Circle Island) was reliable, $F(1,48) = 4.23$, $p < .05$, as was the interaction between passages and presentation, $F(1,48) = 8.57$, $p < .01$.

The mean recall data for Experiment II are shown in Figure 9. It may be noted that the pattern of recall for passage types and presentation orders is identical to the pattern of comprehensibility ratings. The correlation between these dependent measures was computed by comparing across all subjects the rating of a passage by a subject and his recall proportion for that passage. The obtained correlation was significant, $r = .64$, $t(126) = 9.35$, $p < .001$.

For the normal presentation order, mean recall decreased with decreasing amounts of structure in the material: recall for STORYs was best (76%) and recall for DESCRIPTIONs was worst (45%). This relationship is monotonic, although the difference in recall between the AFTER THEME condition (65%) and the NO THEME condition (59%) was small. These results replicate the findings of Experiment I. When the presentation order of sentences was random, there was no effect of amount of structure on recall. This result was expected since with a random structure order, all passages are effectively structureless. The mean

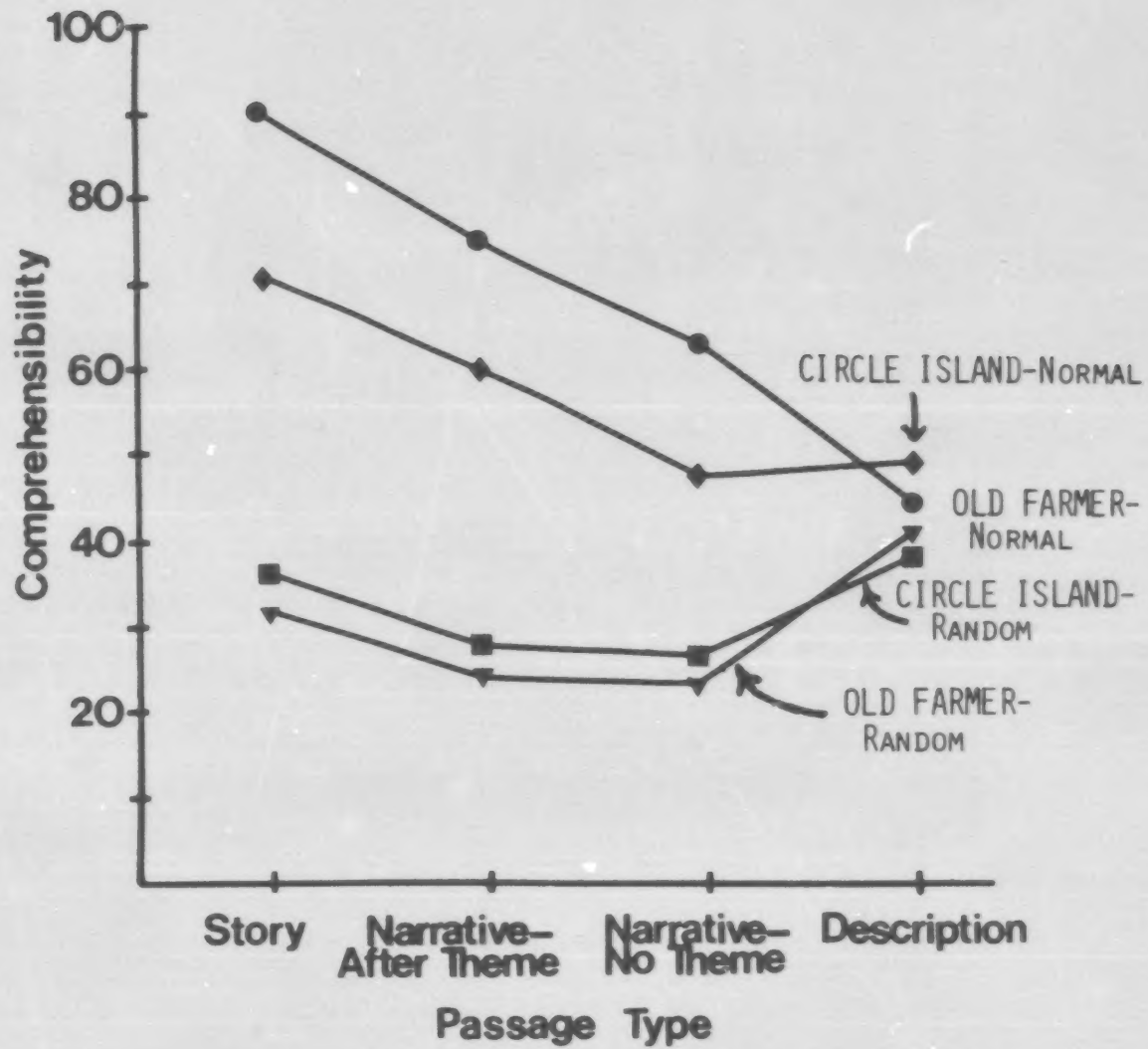


Figure 8. Mean comprehensibility ratings for the Old Farmer and Circle Island passages in Experiment II.

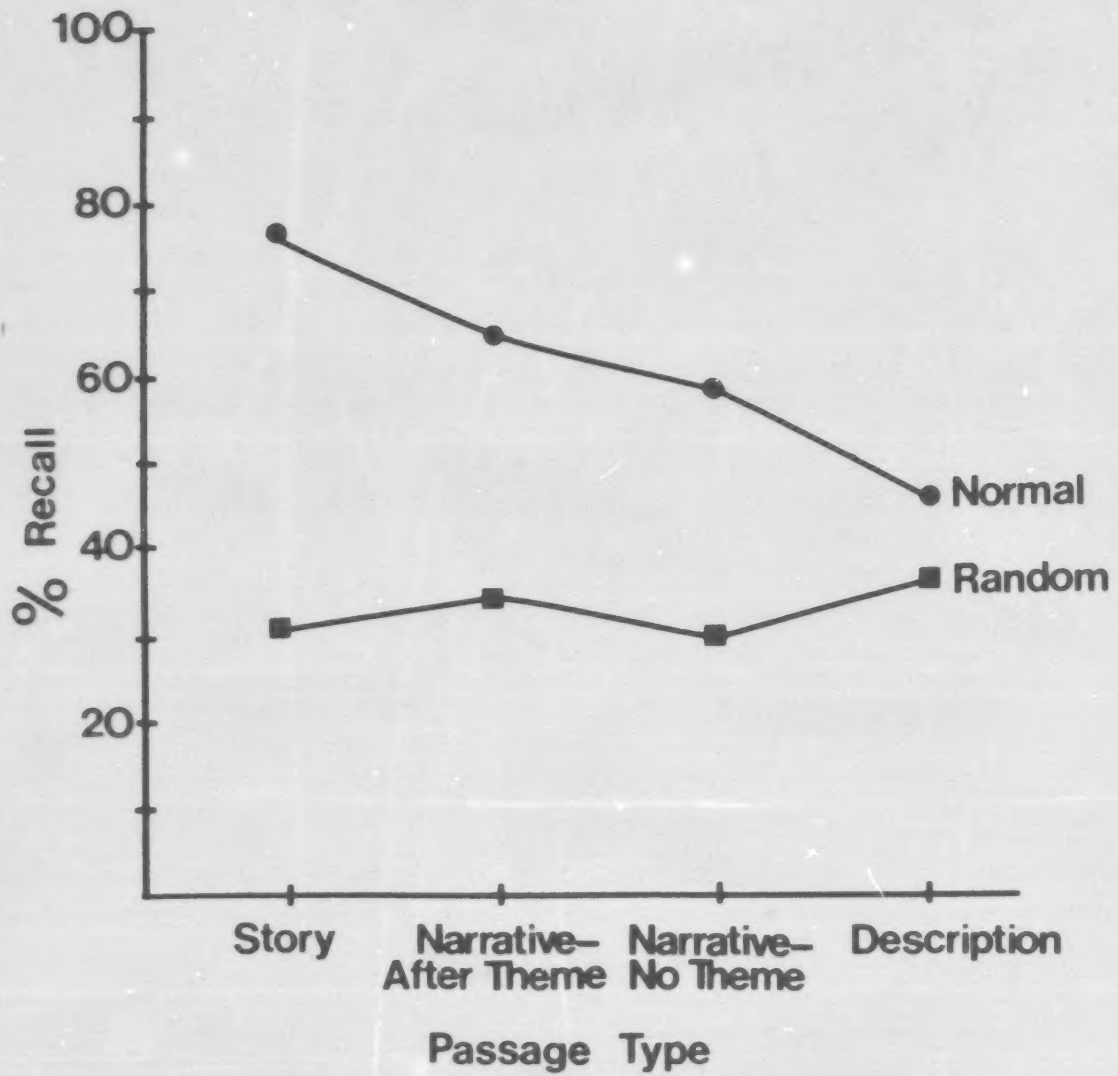


Figure 9. Mean recall probabilities for passage types in Experiment II.

recall level for all four passages fell within a 6% interval, the NARRATIVE-NO THEME condition being the lowest (30%) and the DESCRIPTION condition the highest (36%). Overall, the effect of structure on recall was reliable, $F(3,48) = 3.12, p < .05$. Furthermore, presentation order significantly influenced recall, $F(1,48) = 62.38, p < .001$. The interaction between structure and presentation order was also reliable, $F(3,48) = 4.63, p < .01$. Newman-Keuls tests declared that the means for the random presentation orders were statistically indistinguishable. Furthermore, the DESCRIPTION Normal and Random means did not differ reliably. For Normal presentation orders, the STORY and NARRATIVE-AFTER THEME means were significantly different, as were the NARRATIVE-NO THEME and DESCRIPTION means ($p < .05$ for both). As expected, the mean recall for the NARRATIVE-AFTER THEME passages (65%) was greater than for the NARRATIVE-NO THEME passages, but this difference was not significant.

In Figure 10 these mean recall results are divided into recall for the individual passages. It may be noted that recall for the Old Farmer passages was consistently higher than for the Circle Island passages, especially for normal presentation orders. With the exception of the DESCRIPTION passage, the superiority in recall of the Old Farmer passage over the Circle Island passage for Normal presentation order was greater than 15%. This effect of materials on recall was significant, $F(1,48) = 5.10, p < .05$. In addition, this variable interacted with presentation order, $F(1,48) = 4.87, p < .05$. The reduction in recall with decreasing structure in the passage is preserved for both the Old Farmer and Circle Island passages, as is the lack of effect of structure

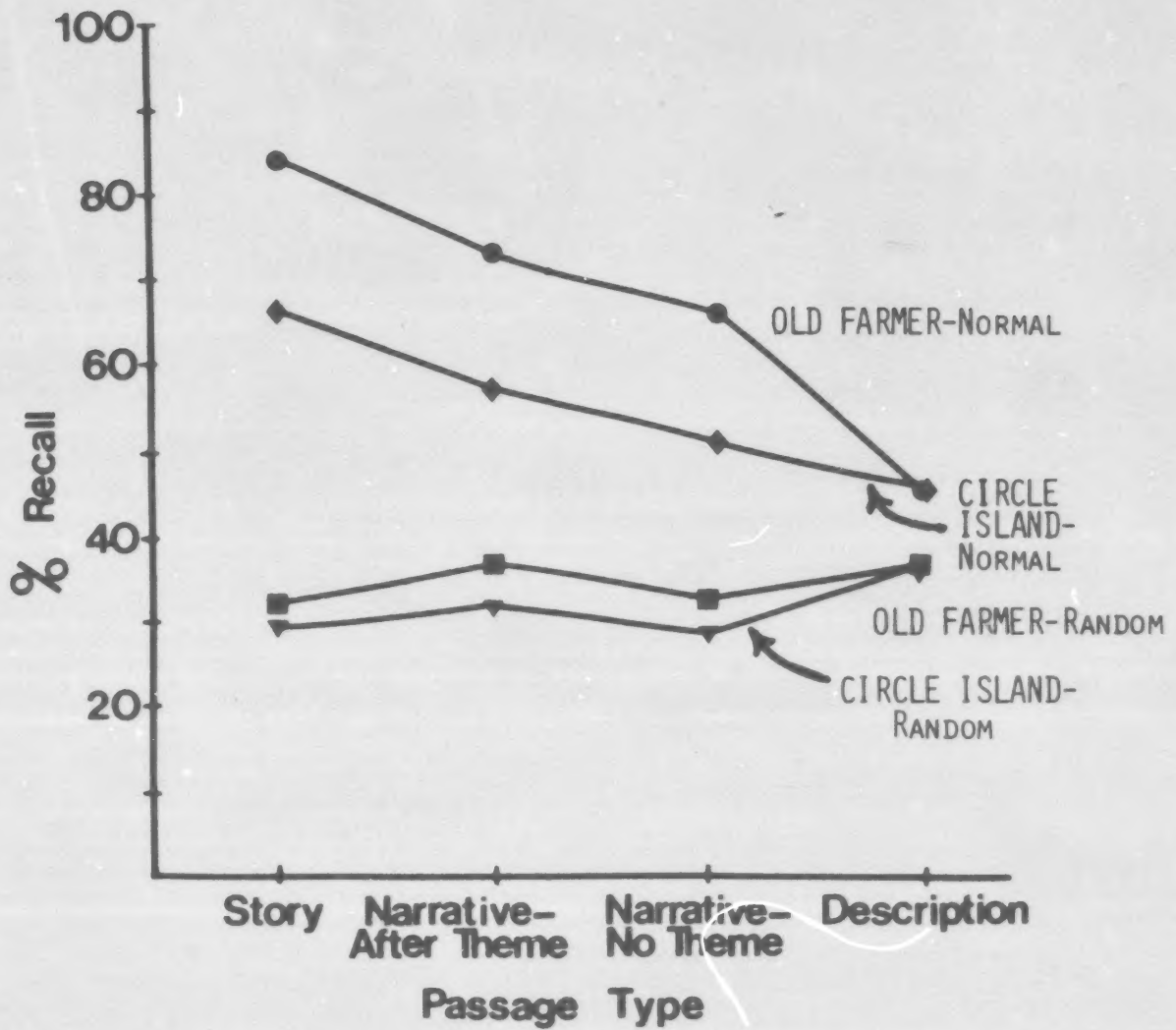


Figure 10. Mean recall probabilities for the Old Farmer and Circle Island passages in Experiment II.

on recall for the random presentation orders. Thus it appears that the effect of varying plot structure on memory for prose is generalizable across different stimulus materials with similar story structures. However, the obtained recall differences between the Old Farmer and Circle Island passages suggest that other properties of the stimuli influence memory. These properties will be considered in more detail in Experiment III.

Figure 11 shows the mean recall levels of the eight variously structured passages as a function of presentation mode. Auditory presentation of the passages led to significantly better recall of the passages than visual presentation, $F(1,48) = 7.04$, $p < .02$. For all passages in Normal order, mean recall was 10% - 16% better with auditory presentation. With random presentation orders, auditory presentation produced 4% higher recall than visual presentation for all passages except DESCRIPTION. The advantage of audio presentation over visual presentation held for both the Old Farmer and Circle Island stories although presentation mode did not interact significantly with materials or structure. However, the interaction between presentation mode and order was significant, $F(1,48) = 4.51$, $p < .05$. Since presentation mode did not interact with structure, the data from visual and audio presentation were combined in the subsequent analyses of structural effects on recall.

The hierarchical relationships among propositions resulting from the structural analysis of plot were a powerful determinant of recall for the most structured passages. Figure 12 shows the recall of propositions from the Circle Island passages as a function of their location

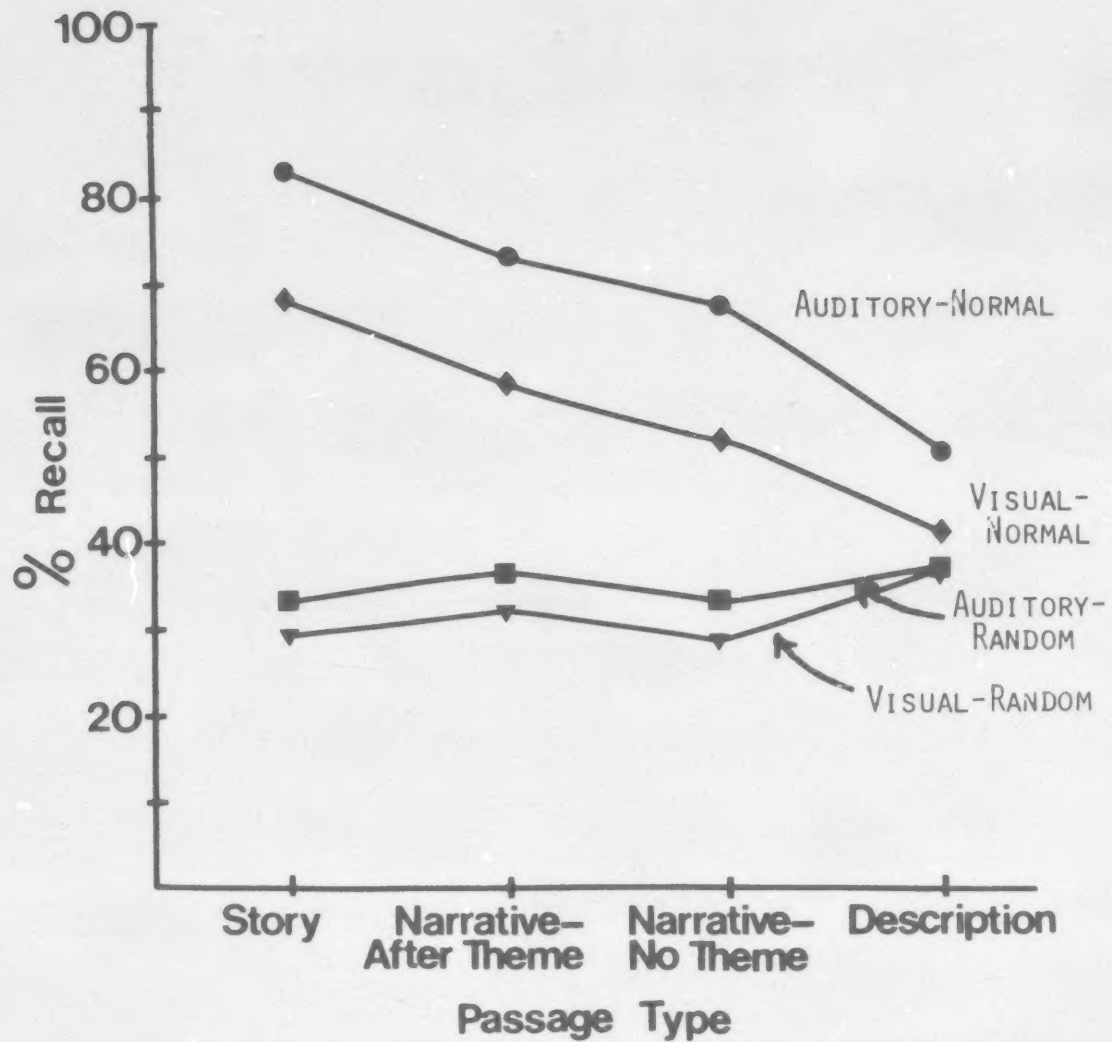


Figure 11. Mean recall probabilities in Experiment II as a function of presentation mode.

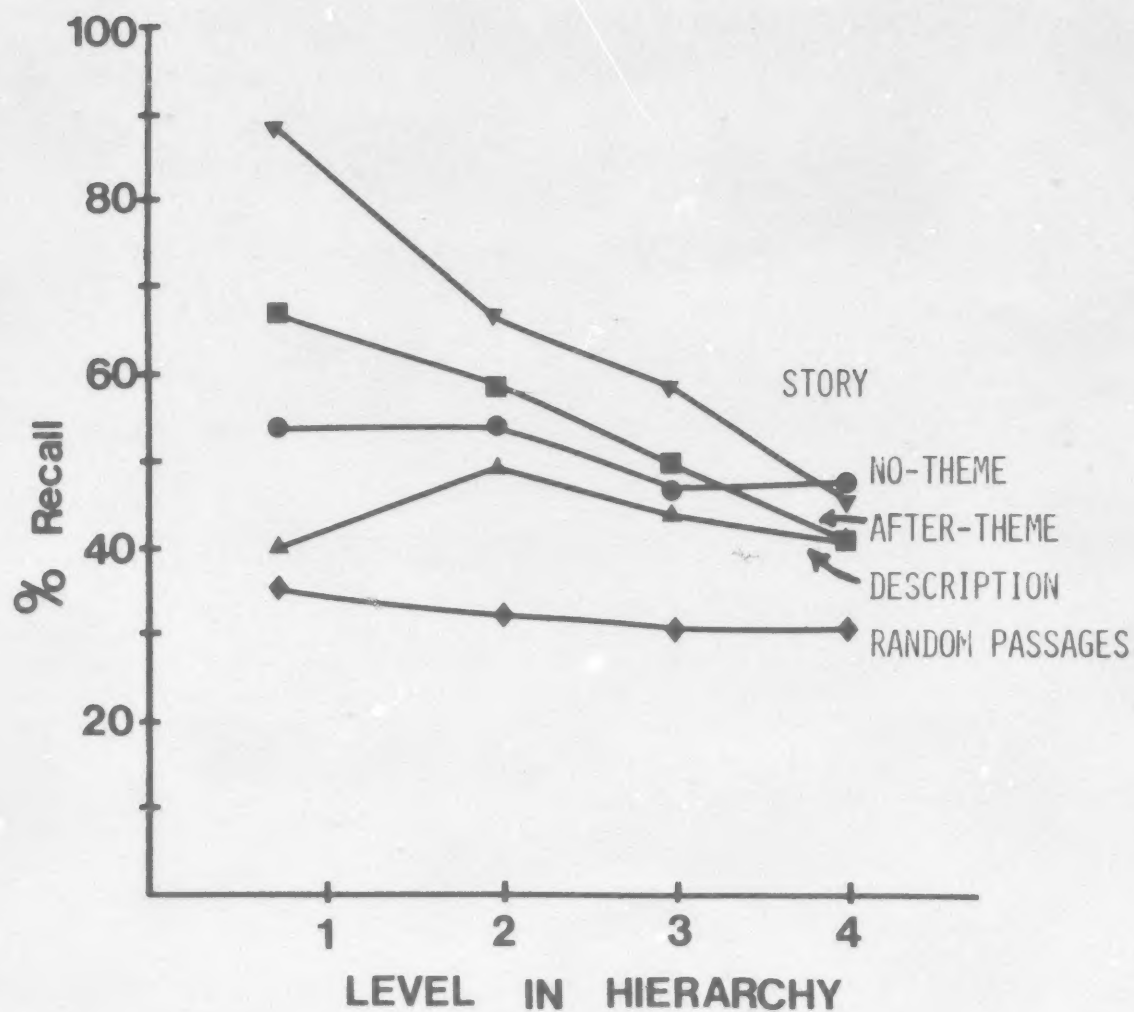


Figure 12. Recall probabilities for propositions of the Circle Island passages as a function of location in the organizational hierarchy.

in the organizational hierarchy. Each point in Figure 12 represents the mean percentage of all propositions at that level in the hierarchy that were recalled by subjects in that structuring condition. The line corresponding to recall of the Random passages represents the mean of all four randomly-ordered passages. The location of propositions in the hierarchy was carefully determined for each of the structuring conditions. For the STORY passage, hierarchical level for propositions was determined by the analysis provided in Figure 1. For the three other structure conditions, the level of a proposition was the same level as that proposition in the STORY passage which corresponded to it in semantic content. Thus for a given level in the hierarchy, the recall of that level across passage types corresponded to a comparison of identical or nearly identical propositions embedded in different structural frameworks. Observed differences in recall, then, could be attributed to structural differences in the passages and not confounded with semantic content of the to-be-recalled propositions. However, this control was possible only for the comparison of recall of a given level across passage type. Within a given passage, comparisons of recall of propositions from different levels necessarily involved propositions with different semantic content.

It may be noted in Figure 12 that the STORY passage recall depended on hierarchical level. For the STORY passage, recall for level 1 propositions was 88%, 67% for level 2, 58% for level 3, and 45% for level 4. For the NARRATIVE-AFTER THEME passage, this monotonic trend was present but the differences were greatly reduced. The difference in level 1 recall between the STORY and the NARRATIVE-AFTER THEME passages

was reliable, $t(7) = 2.96$, $p < .05$, as was the difference in level 1 recall between the AFTER THEME and NO THEME passages, $t(7) = 2.44$, $p < .05$. No recall differences due to level in the hierarchy were obtained for the NARRATIVE-NO THEME, DESCRIPTION, or Random passages.

Figure 13 shows propositional recall as a function of hierarchical level for the Old Farmer passages. Since few observations were available for low levels in the hierarchy, the lower levels have been grouped together for presentation of recall results. The results are similar to those obtained for the Circle Island passages. For the STORY passages, recall probability decreased with descending position in the organizational hierarchy. Recall probability for level 1 (94%) was 21% higher than for levels 13 - 16 (73%). Since overall recall of the Old Farmer STORY was so high, there was somewhat of a ceiling effect that reduced the magnitude of these differences. For the NARRATIVE-AFTER THEME passage, the differences due to hierarchical level were present but reduced. The level 1 and level 2 means differed reliably from the corresponding means in the STORY passage ($p < .05$ for both). No differences due to hierarchical level were obtained for the NO-THEME, DESCRIPTION, or Random passages.

Summarization

Passage summarizations were scored to determine their propositional content and length. Scoring criteria were identical to those used for the recall protocols. The summarization results are shown in Table 2. The means given in Table 2 represent an average of both the Old Farmer and Circle Island passages. In addition, the four randomly-ordered presentation conditions have been averaged together, since these

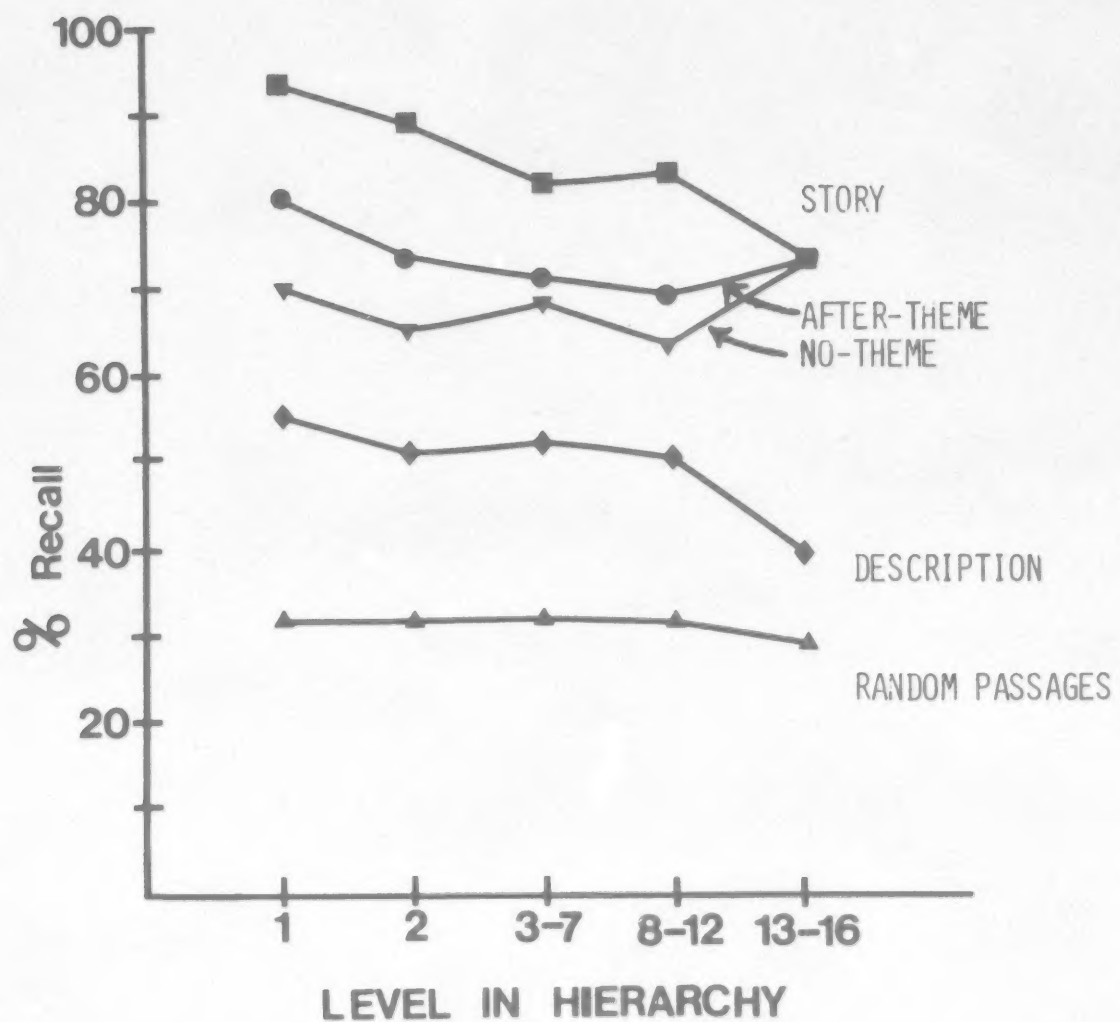


Figure 13. Recall probabilities for propositions of the Old Farmer passages as a function of location in the organizational hierarchy.

Table 2

Mean Propositional Length of Summaries and
Percentage of Recalled Propositions Appearing in Summaries

<u>Passage Type</u>	<u>Mean Length</u>	<u>% of Recalled Propositions</u>
STORY-Normal	8.00	.30
NARRATIVE-AFTER THEME-Normal	8.00	.36
NARRATIVE-NO THEME-Normal	8.25	.40
DESCRIPTION-Normal	9.00	.58
Random Passages	10.25	.89

conditions produced no differences in summary length. For all passage types, the mean propositional length of summaries was approximately the same. The longest summaries were provided by subjects who had received randomly-ordered passages. The second column of Table 2 gives the percentages of propositions from the recall protocols that were included in the summaries. This percentage increased with decreasing structure in the stimulus materials. That is, the structured passages produced summaries in which a **few** structurally central propositions were selected for inclusion in the summary, while the less structured passages produced summaries containing whatever propositions were included in the recall. For less structured passages these propositions were equally likely to come from any level in the organizational hierarchy (see Figures 12 and 13). The obtained proportional differences in summary length were significant, $F(4,35) = 3.56, p < .025$.

Figures 14 and 15 show the distribution of propositions among hierarchical levels in summaries of the Circle Island and Old Farmer STORY-Normal passages. The probability given for each hierarchical level is the mean conditional probability of including propositions in the summary given the propositions were present in the recall protocol. It may be noted that for both stories hierarchical level influenced probability of summary inclusion. Subjects receiving STORY-Normal passages produced summaries which included propositions corresponding to the central structural elements while deleting the detailed actions representing attempts or intermediate outcomes.

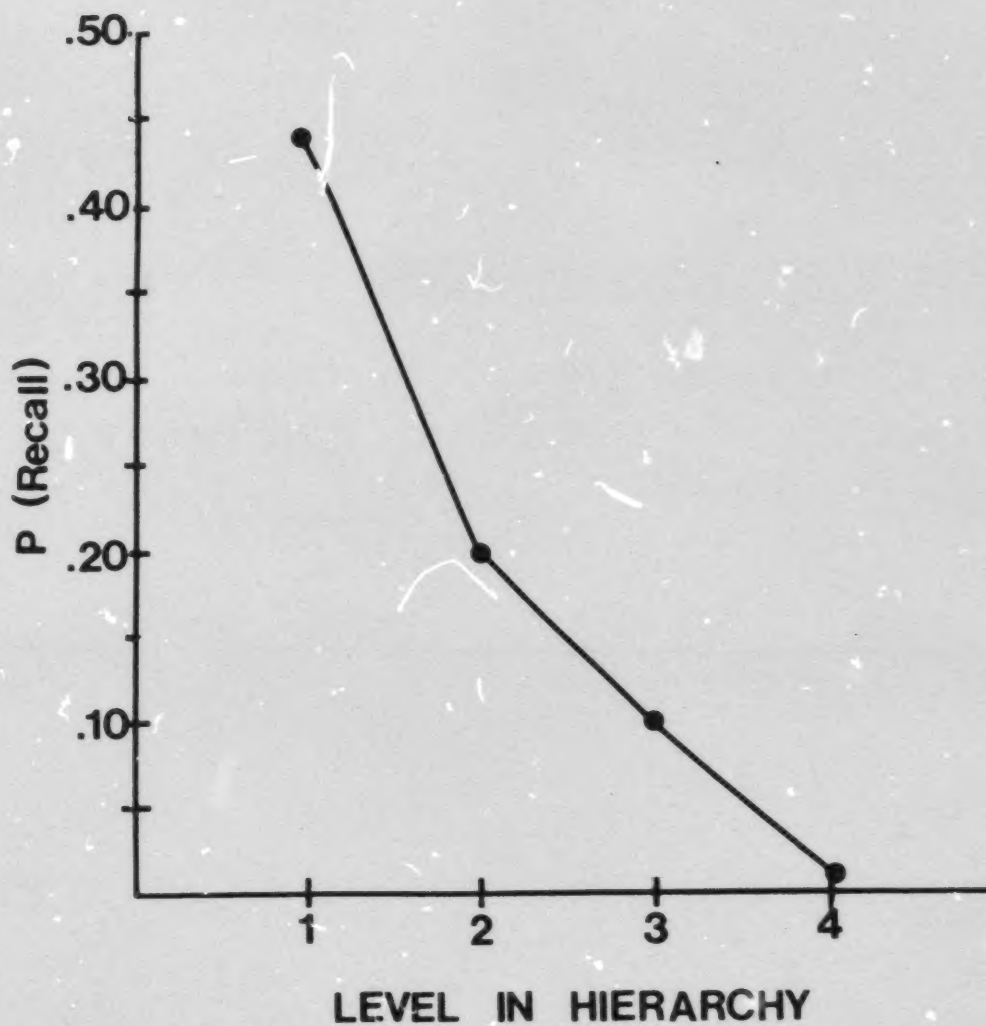


Figure 14. Conditional probability of inclusion of propositions in Circle Island summary given occurrence in recall protocol, STORY-Normal passage.

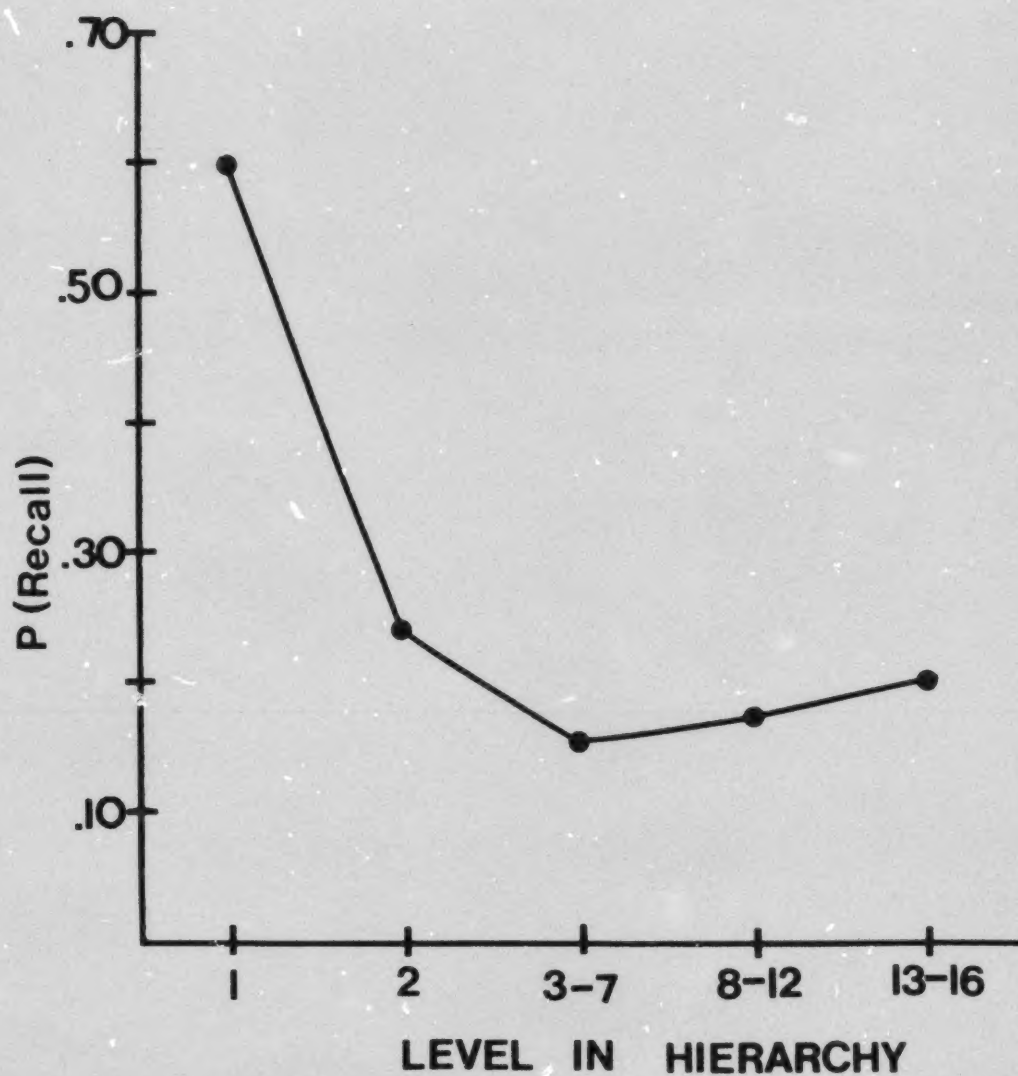


Figure 15. Conditional probability in inclusion of propositions in Old Farmer summary given occurrence in recall protocol, STORY-Normal passage.

Recognition Test

The results of the recognition test are given for each test item type in Table 3. There were five item types, each with several exemplars on the recognition test for both the Circle Island and Old Farmer passages. True items consisted of statements occurring in the story or acceptable paraphrases of these statements. The remaining four item types were various types of distractor items, referred to here as True Summarization, Incorrect Inference, Incorrect Filler, and False Statement. True Summarizations were statements representing a correct summarization of information appearing in the story, but omitting other information that was included in the original text. For example, one item of this type was

- (1) As soon as the cat scratched the dog, the dog scared the donkey into the shed.

While this is a true summarization of the events of the story, it omits the intermediate events of the dog barking and the barking frightening the donkey.

Incorrect Inferences consisted of two true events from a passage linked in the distractor statement by a false inference relating the events. For example, one such item from the Old Farmer passages was

- (2) The cat did not have any milk so it scratched the dog.

While both assertions about the cat were true (it didn't have milk and it scratched the dog), the causal connection between the two was not true in the story.

Incorrect Filler refers to statements in which a true event frame from a story had substituted into one of its IMPs detail contradicting

Table 3

Results of Recognition Test in Experiment II

Item Type	Experimental Condition							
	STORY- Normal	NARR. AFTER THEME Normal	NARR. NO THEME Normal	DESCR. Normal	STORY- Random	NARR. AFTER THEME Random	NARR. NO THEME Random	DESCR. Random
True Statement: Probability (Hit)	.80	.72	.65	.60	.56	.48	.58	.53
True Summarization: P(False Alarm) ¹	.55	.46	.41	.30	.18	.26	.25	.25
Incorrect Inference: P(False Alarm) ²	.12	.20	.27	.27	.42	.31	.31	.44
Incorrect Filler: P(False Alarm) ²	.84	.78	.55	.50	.61	.72	.72	.69
False Statement: P(False Alarm) ²	.12	.12	.06	.07	.23	.25	.25	.25

¹Probability of the response "Statement was in the passage."

²Probability of responding either "Statement was in the passage," or "Statement was true about the passage."

that which was specified in the original text. For example, one of the propositions from the Circle Island passages was

(3) The island farmers wanted to build a canal across the island. The Incorrect Filler distractor created from this sentence is given in (4):

(4) The island ranchers wanted to build a canal across the island.

False Statements were items for which no information suggesting their validity appeared in the original texts. These statements were neither true, inferable from true statements, nor derived from true statements. Such an item is given in (5):

(5) The farmer trained his dog to bark loudly.

For each test item, subjects made one of three possible responses. They either judged the statement to be true (i.e., stated explicitly in the passage), inferable from the information in the passage but not stated explicitly, or false (neither true about nor inferable from the passage). In Table 3, mean hit rates for true items and false alarm rates for distractors are shown for subjects in the eight structure and ordering conditions. For True Summarizations a false alarm is defined as a true response to items of this type. For all other distractor items a false alarm is defined as either a true or a "not-stated-but-inferable" response. For True Statements a "hit" was scored only if a subject responded true to an item.

The hit rate for true statements on the recognition test decreased monotonically for normal presentation orders with decreasing structure. For the four randomly-ordered conditions the hit rates were nearly equal. The hit rate for DESCRIPTION-Normal (.60) was nearly equal to

the mean for the four randomly-ordered conditions (.54). The interaction of structure and presentation order for True Statements was reliable, $F(3,56) = 2.83$, $p < .05$.

False alarm rates for both Incorrect Fillers and True Summarizations decreased with decreasing structure for the Normal presentation conditions, while no differences in false alarm rates were obtained for the random presentation orders. For both of these distractor types, the interaction between structure and presentation order was significant ($p < .05$). However, the probability of a false alarm for Incorrect Inferences increased with decreasing structure for the normal presentation orders, although this result failed to achieve significance. For False Statements, a main effect of presentation order was obtained for false alarm rates, $F(1,56) = 6.37$, $p < .02$, with false alarm rates being higher for the randomly ordered conditions. There was no interaction between structure and order for this item type.

Discussion

The results of Experiment II generally replicate and extend the findings of Experiment I. In both studies rated comprehensibility of a passage correlated well with recall of the passage. Both measures were highly predictable from the amount of plot structure present in the passages. As the amount of structure decreased, both comprehensibility and recall levels decreased. This result was obtained despite the fact that the number and content of individual propositions was nearly identical in the various structuring conditions.

In Experiment I subjects' recall was measured using an incidental learning procedure. In Experiment II an intentional learning procedure

was used. A comparison between recall levels in incidental and intentional learning situations is provided by Figures 6 and 10. The data points in Figure 10 corresponding to those in Figure 6 are STORY-Normal, NARRATIVE-AFTER THEME-Normal, NARRATIVE-NO THEME-Normal, and STORY-Random for the Old Farmer story. It may be observed that recall levels in the incidental learning situation are nearly equal to those in the intentional learning situation. With intentional learning instructions, mean recall for the STORY-Normal, AFTER THEME, and NO THEME passages was 83%, 73%, and 67%, respectively. With the incidental learning procedure of Experiment I the equivalent recall levels were 80%, 68%, and 56%. With the random presentation order, incidental learning produced slightly higher recall (38%) than intentional learning (36%). The procedures of the two experiments were not, of course, identical except for the subjects' instructions. In Experiment I subjects received a printed copy of the passage with unlimited reading time. In Experiment II presentation mode varied (audio or visual) and presentation time was a fixed constant. Nonetheless, the similarity of recall levels was slightly surprising, especially in light of the fact that half of the subjects in Experiment II had received the Circle Island passage first, and hence had received what amounted to a practice trial with the presentation and recall procedure.

One surprising result of Experiment II was the fact that audio presentation produced consistently higher recall than visual presentation. This difference was obtained for all structuring and ordering conditions, despite the fact that total presentation time was equated for both presentation modes of a given passage type. Since recall of

a passage immediately followed presentation of the passage, it appears on the basis of these data that immediate memory for auditory information is superior to immediate memory for visually-presented material. No data testing the maintenance of this difference over longer retention intervals were obtained.

One procedural artifact may have influenced the differences in recall due to presentation mode. In visual presentation, the amount of information in a given exposure was equated by line length, rather than number of propositions or number of sentences. Hence the end of a line would often break within a sentence, proposition, or syntactic constituent. This procedural decision was dictated by the large variation in sentence lengths within each of the passages. Sentences contained varying numbers of propositions. Assuming a subject has a constant reading rate, presenting an entire sentence in each exposure would imply that differential intervals of time would be spent by the subject in attempting to integrate the various propositions into the organizational structure. Specifically, a sentence with few propositions would require much less reading time than a sentence with many propositions. This result has been demonstrated to occur regardless of sentence length (Kintsch & Keenan, 1972). Hence much more time would be available to attempt to integrate propositions into the current organizational frame when only few propositions were present in an exposure. This would be highly undesirable in an intentional learning procedure, since it is assumed that subjects attempt to use organizing frames to encode information for later recall. It was hoped that by equating each exposure for line length, the amount of integration time for each

proposition would average out in the long run, thus minimizing any potential systematic bias in organizational ability due to sentence or proposition length.

Reliable differences attributable to passage content were obtained for both comprehensibility ratings and recall. For equivalent structuring conditions the ratings and recall of the Old Farmer passage were consistently higher than for the Circle Island passages. These differences suggest that other properties of the stimulus materials besides structure influence memory. Two possible factors contributing to the observed differences are the relative simplicity and concreteness of the characters in the Old Farmer passages and the redundant, recursive nature of the plot. The Circle Island passages utilized characters and actions which were less concrete and familiar than those in the Old Farmer passages. Furthermore, the Old Farmer passages have episodic units that are repeated in recursive embedding. No such repetition occurs in the Circle Island passages. It is possible that this repetition of episode structures and concreteness and familiarity of content are responsible for the higher comprehensibility and recall of those Old Farmer passages in which the identification of structure is a processing aid. These potential effects will be considered in detail in Experiment III.

The recall results for passages with Normal presentation orders support the processing assumptions given in Chapter 4. Subjects appear to comprehend and encode stories by instantiating generalized plot frames with particular structural details of the passage they are exposed to. The less structured a passage is, the more difficult this

mapping operation is to perform, and hence the lower is the subsequent recall level. Direct evidence for the claim that subjects use these organizing frames is available from a comparison of recall in the NARRATIVE-AFTER THEME and NARRATIVE-NO THEME conditions. These conditions differed only in a single proposition at the end of the passage. In the AFTER-THEME condition this proposition provided a statement of the top-level goal of the story. This additional information produced restructuring of the encoded passage information, leading to higher recall than for the NO-THEME condition. This difference in recall level for the two conditions was in the expected direction, though not at a significant level, for both Old Farmer and Circle Island passages and both visual and auditory presentation nodes. The claim that obtained recall differences were due to organizational factors is further supported by considering the hierarchical analysis of recall results. For both the Old Farmer and Circle Island passages there was an effect of hierarchical location on recall probability of propositions for the STORY passages. No effect of position in the hierarchy was obtained for the NO-THEME conditions. For the AFTER-THEME passages, however, differences in recall due to hierarchical location were obtained. In particular, the advantage in recall of the AFTER-THEME over the NO-THEME conditions occurred primarily in the additional recall of structurally central propositions located high in the hierarchy. Insofar as the restructuring of information occurred in memory, the pattern of recall began to resemble that for the STORY passages.

As expected, varying the amount of structure in the passage did not influence recall when the sentences were randomly arranged. The

identification of structural dependencies relies on the expected order of occurrence of the major story sub-parts and temporal and causal relationships among juxtaposed events. When these cues are removed from the passages it is impossible to utilize generalized structural information, and learning of the passage is reduced to the learning of a set of unrelated sentences. For the DESCRIPTION passages, virtually no plot structure was identifiable from the material. Thus for this passage type, there was no significant difference between Normal and Random presentation orders.

Subjects' internal organization of the experimental passages was further reflected in the summaries they provided. While the summaries for all structuring conditions were of approximately the same length, the character of the summaries was vastly different. For the STORY passages the summaries represented only a small proportion of the recalled facts of the story. The particular facts selected for inclusion in the summaries represented structurally central propositions located at or near the top of the representational hierarchy. Details and specific actions were systematically excluded from the summaries. For the unstructured passages, summaries represented a much larger proportion of the total of recalled propositions. The content of these summaries consisted primarily of details of the setting or individual events from the passage, with no relationship to structural centrality. These summaries indicate the difficulty subjects experienced in structurally organizing the information in these passages.

The data from the recognition provide some indication of the nature of the information remembered from the passages by subjects in the

various structuring conditions. When the passages contain identifiable plot structure, subjects identify and instantiate prototypical frames with specific information from the passage. Much of the processing effort in these conditions is devoted to establishing the abstract structural relationships among events and characters. Hence much of the detailed surface information is forgotten. However, when the passages are less structured more processing effort is devoted to retaining surface information from the passages. This claim is supported by the false alarm data for True Summarizations and Incorrect Fillers. For both of these item types, the underlying idea from the original text is preserved but detail in the surface structure is changed. For the True Summarizations, the changed detail is the summarization of several events from the passage into a single statement that did not occur originally. For the Incorrect Filler an event occurring in the passage was altered in a single detail of time or character involvement. For these item types errors were most frequent in conditions in which the passages were well-structured, and errors decreased with decreasing structure.

For the Incorrect Inferences, however, single events from the passages were causally linked incorrectly in the test items. While the surface forms of the events were intact, then, the structural relationship of the events was altered to form the basis of the falsification of the statement. For these item types false alarm rates increased with decreasing structure. That is, when the original passage was well-structured the causal relationships among events were easily established. Thus Incorrect Inferences could easily be rejected as false.

When the passages were poorly structured, subjects noted surface forms but were unable to infer structural relationships. Thus they frequently false alarmed to Incorrect Inferences, in which the component events of the test item were individually true in the story but the structural relationship was not.

CHAPTER 6
EXPERIMENT III

The results from Experiments I and II demonstrate the importance of the use of organizing frames in comprehension and memory for prose passages. For two particular stories, comprehensibility and recall were predictable from the amount of inherent plot structure in the material. In addition, the differences in recall for the Old Farmer and Circle Island stories in the Normal presentation condition suggest the possible influence on recall of other variables, such as concreteness, simplicity of plot structure, and typicality of the events. We now consider how to characterize differences between two stories of equivalent structural grammaticality. For example, the STORY-Normal versions of both the Old Farmer and Circle Island stories are structurally equivalent at a very general level: they utilize approximately the same number of characters, they both obey standard narrative conventions for temporal and causal ordering of events, and they both have identifiable goals, event sequences that are attempts to achieve the goal, and conclusions relating to the goal. Yet there is a sizable difference in the rated comprehensibility and mean recall level of the stories.

To a great extent, stories of the approximate complexity of these may be characterized on two dimensions--their structure and their content. The concept of structure has been used throughout this paper to refer to the functional relationships existing among the components of a story plot, independent of any particular set of characters or the specific actions they perform. Story content refers to the semantics of the individual propositions of the story: the set of characters, specific

setting information, and the actions taking place among the characters. These two dimensions are distinct in that they may be more or less independently manipulated in the process of constructing stories. So, for example, different stories may be constructed within the same structural framework, by varying the semantic content of the passage while holding the plot structure constant. Such pairs of stories would be useful in studying similarities in cognitive organization and memory for stories having differing semantic content but the same formal structure. Such a manipulation would allow the assessment of the effects of such variables as linguistic complexity, meaningfulness of the passage, and imagery on memory for stories. Furthermore, if these variables were manipulated in a story context, their effects could be assessed in a relatively naturalistic processing environment, rather than in a set of isolated, unrelated sentences.

Conversely, a potential experimental manipulation might involve the construction of stories with different underlying plot structures but with identical settings and character sets. Such a manipulation would permit an independent assessment of the influence of particular plot structures on comprehensibility and recall, while controlling for potential differences in comprehensibility due to content. In the most extreme case, such a manipulation would require holding constant the semantic content of each individual proposition, while altering the inferable structural relationships of the plot sequence. This was precisely the manipulation performed in Experiments I and II, in which the semantic content of individual propositions in the presented passages was held constant across conditions which differed in the amount of inherent

plot structure.

Another possibility for the manipulation of structure would involve the repetition of the character set and setting in two successive unrelated but equivalently well-structured stories. For example, the old farmer and his animals might appear in a second story with a different theme, plot structure, and event sequences. This manipulation would provide a measure for the extent to which comprehensibility and recall of the passages was due to structural simplicity rather than simplicity and familiarity of the character set and context.

The observed differences in rated comprehensibility and recall between the Old Farmer and Circle Island stories may be interpreted within the analytic framework described above. Structurally, the Old Farmer story is well-defined and simple. Each action of the story is an attempt to achieve a specific goal, and the nesting of goals and subgoals provides a structural redundancy contributing to the story's simplicity and comprehensibility. Further redundancy in the story is provided by the repetition of the same information in successive sentences, as in (1) and (2):

- (1) . . . The farmer asked his dog to bark loudly at the donkey and thereby frighten him into the shed . . .
So then, the farmer asked his cat to scratch the dog so the dog would bark loudly and thereby frighten the donkey into the shed.
- (2) . . . As soon as the cat got the milk it began to scratch the dog. As soon as the cat scratched the dog . . .

Another device providing redundancy in the Old Farmer story structure is the repetition of surface forms in the description of similar actions, as in (3) and (4);

(3) . . . First, the farmer pulled the donkey, but the donkey wouldn't move. Then the farmer pushed the donkey, but still the donkey wouldn't move

(4) . . . As soon as he gave the hay to the cow

As soon as the cat got the milk

As soon as the cat scratched the dog

The effect of these repetitions on a story comprehender is to reduce the amount of new narrative information in the input stream, increase the extent to which previously-created structures for events may be utilized in the comprehension of current propositions, and to make explicit the causal relationships among events. In addition, the overall plot structure is a familiar one which has been utilized in numerous simple stories; hence the frame for the story's structure is one already familiar to subjects.

In contrast, the Circle Island plot is not highly stereotypical in its structure. There is little inherent redundancy in the passage in terms of repetition of propositions or surface forms. As such, subjects should find the construction of the appropriate organizational frames more difficult than for the Old Farmer story. If this were in fact the case, then the observed results of lower rated comprehensibility and mean recall would be expected.

Similarly, the content of the Old Farmer story is simpler, more comprehensible, and more concrete than that of the Circle Island story.

In the former, the characters consist of a farmer and familiar farm animals: a dog, a cat, a cow, and a donkey. Furthermore, the animals' actions in the story are stereotypical of their normal behaviors: the donkey stubbornly balking, the dog barking, the cat drinking milk, and the cow eating hay and giving milk. The use of these standard, highly-frequent animals and their associated actions in the story means that previously-learned frames may be accessed and used by subjects in comprehending and remembering the story. By contrast, it would be expected that if the animals of the Old Farmer (Old Zookeeper) story had instead been a gnu, a lemur, an iguana, and a penguin engaged in uncharacteristic actions, the mean recall level and comprehensibility ratings for the story would be reduced. In the Circle Island story, a new "character" was introduced, the pro-canal association; the other characters (senators, farmers, ranchers) were less concrete and familiar than the farm animals. Furthermore, the existence of the Circle Island characters in the story was less obviously suggested by the context and setting of the story than in the Old Farmer story, and the actions carried out by these characters are not highly associated with them.

Therefore, establishing the roles and relationships of the characters in the Circle Island story would be expected to require more learning than for the Old Farmer story, since less extra-experimental knowledge could be brought to bear in making those assignments. Thus it would be predicted on the basis of content differences that comprehensibility and recall of the Circle Island story should be lower than for the Old Farmer story.

Experiment II provided some experimental evidence for these expectations in the form of higher mean comprehensibility ratings and recall levels for the Old Farmer story than for the Circle Island story. However, because of the confounding of structure and content differences between the two stories, it was impossible to assess to what extent each of these dimensions contributed to the observed differences. It was of interest to determine the independent effects of structure and content on memory in a controlled experimental situation. In Experiment III passages with controlled structure and content were presented to subjects for later recall. The concreteness and familiarity of the content of the passages was varied, as was the structure of the plot, in order to determine their separate effects on recall.

Two passages were presented in sequence, and the relationship between the two passages was systematically varied. In one condition, the two passages were identical in plot structure but differed in the particular set of characters and their actions. It was of interest to determine whether the repetition of a plot structure in two stories would reinforce the structural frame for the plot and hence facilitate learning of the second story, even though it contained unrelated characters, actions, and a different setting. In a second condition, the set of characters remained constant, whereas the structure of the two stories varied. Thus, a story with a given set of characters would be followed by a new story, structurally unrelated, with the same characters. Two alternative hypotheses for the expected effects of this manipulation are possible. If presentation of the first story introduces unfamiliar or abstract concepts for which referential contexts and relationships

are established, then these relationships might be maintained and utilized in a second story. The repetition of these characters and relationships in a second passage would allow subjects to utilize the structures encoding the relationships among characters which had been formed during comprehension of the first passage. This priming effect for characters, similar to the one described above for plot structures, might be expected to facilitate second-passage learning by providing increased meaningfulness to the characters and their relationships.

If, on the other hand, contextual and relational information about characters provided in the first story was unrelated or inappropriate to the second story, then the repetition of character sets would have interfering effects on the learning of the second story. On subsequent recall, then, it would be expected that this proactive interference would produce a reduction in recall levels relative to a condition in which the character set was not repeated.

Method

Materials

Four stories were used, representing two distinct plot structures and two character sets. The structures (denoted hereafter by S) were taken from the STORY-Normal passages of Experiment II. The structure of the Farmer story (S_F) consists of a statement of a desired goal condition, followed by a series of attempts by the main character to achieve the goal. Each subsequent attempt results in the creation of a nested subgoal (to a depth of four), and eventually each subgoal is achieved and the top-level goal is attained. The structure of the

Circle Island story (S_C) involves the statement of a goal and the creation of a subgoal by the main character, the attainment of which is presumed to lead directly to the attainment of the main goal. However, after the attainment of the subgoal, another character intervenes and prevents attainment of the top-level goal. The resolution of the story is the planned or accomplished retaliation by the main character for denial of the goal.

From each of these structures two stories were constructed by using abstract or concrete character sets (denoted by C). These character sets corresponded closely to those utilized in the passages of Experiment II. The concrete character set (C_F) consisted of the characters from the Farmer story: the farmer, his donkey, his dog, his cat, and his cow. The passage utilizing these characters and the Farmer structure ($S_F C_F$) was precisely the STORY-Normal passage of Experiment I (see Appendix Ia). Another passage was constructed utilizing these characters and the plot structure of the Circle Island story ($S_C C_F$). This passage is presented in Appendix IIIa. Similarly, an abstract character set was used with the two structures to produce two other stories. This character set was similar to the set used in the Circle Island passages of Experiment II, but was altered so as to be less concrete and meaningful. The characters were three arbitrary, abstract groups called the Populists, the Federalists, and the senators. The story constructed from this character set and the Circle Island structure ($S_C C_C$) differed from the STORY-Normal passage of Experiment II only in the substitution of the terms Populists and Federalists for farmers and ranchers (see Appendix IIIb). The other passage ($S_F C_C$)

involved the Federalists' attempt to win passage of a bill in the Senate with the ensuing creation of four nested subgoals and the eventual success of the bill. This passage is presented in Appendix IIIc.

Subjects

Forty-eight Stanford undergraduates participated in the one-hour experiment for either \$2.00 pay or to satisfy a course requirement.

Design

A 2 X 2 X 3 between-subject design was used. The independent variables were character set of Story 2 (concrete: C_F , and abstract: C_C), plot structure of Story 2 (S_F and S_C), and the relationship between Story 1 and Story 2. The three types of sequential relationships between stories 1 and 2 were same structure, same characters, or unrelated. In the unrelated condition a subject would receive as his second story the one passage of the remaining three which shared neither structure nor content with his first passage. For example, a subject in this condition would receive as his two stories either the pair $S_F C_F - S_C C_C$, or the pair $S_F C_C - S_C C_F$. In total, then, there were 12 possible sequences of story pairings.

Procedure

Subjects were tested in groups varying in size from one to four people. An incidental learning procedure was used. Subjects were instructed that they would be presented a set of stories, one at a time, for which they were to perform several ratings on a 1 (low) to 10 (high) scale. Ratings were performed on three dimensions: comprehensibility,

imagery, and meaningfulness. The comprehensibility instructions were identical to those in Experiments I and II. For imagery, subjects were instructed to rate how vivid a mental picture or image they could construct of the actions and characters portrayed in the story. For meaningfulness, subjects rated the extent to which they could identify the characters and actions of the story to previous experiences they had had, other stories they had read, or familiarity they had with the characters and problems being discussed.

Passages were presented visually. An overhead projector displayed the stories on a wall in front of the subjects. Each exposure contained one entire sentence, and a five-second interval was used for each exposure. Since the stories varied from 16 to 18 sentences in length, total stimulus presentation time was approximately 90 seconds. After presentation of the first story by this method, subjects performed the three ratings. The procedure was then repeated with the second story. When subjects had completed the ratings for the second story, they performed an unrelated interpolated reading task for approximately 30 minutes. Subjects were then instructed to recall verbatim the first passage they had been presented. Recall instructions were identical to those in Experiments I and II. Recalls were written on a blank sheet of paper, and unlimited recall time was allowed. When recall was completed for the first story, subjects were asked to recall the second story in the same manner.

Results

Subjects' mean ratings of Comprehensibility, Imagery, and Meaningfulness were computed for each story type and combined across both serial positions. The mean ratings for the various stories are given in Table 4. For Comprehensibility, the mean rating for S_F , the two stories utilizing the Old Farmer structure (8.73), was greater than those stories utilizing the Circle Island structure ($S_C = 7.48$). This difference was significant, $F(1,92) = 9.10$, $p < .005$. There were no significant differences in Comprehensibility ratings due to either Characters or the interaction between Structure and Characters. For Imagery Ratings, there was a large difference in mean ratings for those stories using the Old Farmer characters ($C_F = 7.73$) and those using the Circle Island characters ($C_C = 5.16$). This difference was highly reliable, $F(1,92) = 28.63$, $p < .001$. No significant differences due to Structure or interaction were obtained for Imagery ratings. For Meaningfulness, no differences were obtained due to either Structure or Characters. Since it was possible that the effect of repeating a character set across stories might increase the subjective meaningfulness of the second story, the Meaningfulness ratings for the second passage presented were computed for both new and repeated Character sets. The mean rating for new character sets thus obtained (5.06) was greater than for repeated character sets (4.56), but this difference was not significant.

In addition to the three ratings for a presented story, the total number of propositions recalled for the story was determined for each subject by scoring the recall protocols for gist according to the procedures used in Experiments I and II. Since the total number of propositions varied slightly for the four stories (between 33 and 37),

Table 4

Mean Ratings of Stories Used in Experiment III

<u>Story</u>	<u>Comprehensibility</u>	<u>Imagery</u>	<u>Meaningfulness</u>
S _F C _F	9.17	5.04	4.92
S _C S _F	7.52	7.43	4.52
S _F C _C	8.29	5.25	4.42
S _C S _C	7.46	5.08	5.17
Mean S _F	8.73	6.64	4.67
Mean S _C	7.48	6.25	4.84
Mean C _F	8.34	7.73	4.72
Mean C _C	7.87	5.16	4.79

recall scores were converted to proportions. The arcsin transformations of these proportions were used in statistical tests to insure homogeneity of cell variances.

The relationship between rated comprehensibility and recall was determined by correlating these obtained measures across all story types and pairing conditions. As expected, there was a significant correlation between rated comprehensibility and subsequent recall, $r = .55$, $t(94) = 6.45$, $p < .01$. Similarly, there was a significant though smaller correlation between rated imagery and recall for all passages, $r = .37$, $t(94) = 3.87$, $p < .01$.

Overall, recall of the stories improved with practice. The mean recall level of all stories presented first was 40%, while mean recall of stories presented second was 49%. These means differed reliably, $F(1,24) = 8.49$, $p < .01$. Both Structure and Character variables influenced recall. Across the entire experiment, recall of stories using the Old Farmer structure (54%) was significantly greater than recall of stories using the Circle Island structure (35%), $F(1,24) = 21.51$, $p < .01$. Similarly, mean recall of stories using the Old Farmer character set (49%) was reliably greater than recall of stories using the Circle Island character set (40%), $F(1,24) = 8.18$, $p < .01$. None of the interactions among Structure, Character, or Serial Position were significant.

Separate analyses of variance were performed on the data from the first and second story recalls, in order to assess as an independent variable the effects of the three types of inter-story relationship on recall. For the stories presented first to subjects, both the Old Farmer structure and characters produced better recall. The mean recall

of the story types was 60% for $S_F C_F$ (Old Farmer structure and characters), 40% for $S_F C_C$, 34% for $S_C C_F$, and 26% for $S_C C_C$. The effect due to Structure was significant, $F(1,36) = 7.16$, $p < .02$, as was the effect due to Character set, $F(1,36) = 14.28$, $p < .01$. The results of both recall and comprehensibility ratings replicate the findings of Experiment II. In that experiment, the Old Farmer story in the STORY-Normal condition (designated as $S_F C_F$ here) produced higher comprehensibility ratings and recall levels than the Circle Island story (designated as $S_C C_C$ here). Overall, mean recall levels were lower for the stories in Experiment III than in Experiment II. This result may be attributed primarily to the use of an intentional learning procedure in Experiment II and an incidental learning procedure here.

First story recall was not influenced by which story followed it in the presentation sequence. Overall, recall level of the first story was 39% when followed by presentation of an unrelated story, 45% when followed by a story utilizing the same structure, and 36% when followed by a story with the same character set. These percentages were not reliably different.

The results for second story recall are summarized in Figure 16. The proportion of propositions recalled is given as a function of story type and relatedness between the first and second stories. It may be noted that in five out of six instances the mean recall for stories using the Old Farmer structure was higher than for the corresponding story (i.e., the story with the same character set) using the Circle Island structure. This main effect of the Structure variable on recall was reliable, $F(1,36) = 18.32$, $p < .01$. Considering the Character

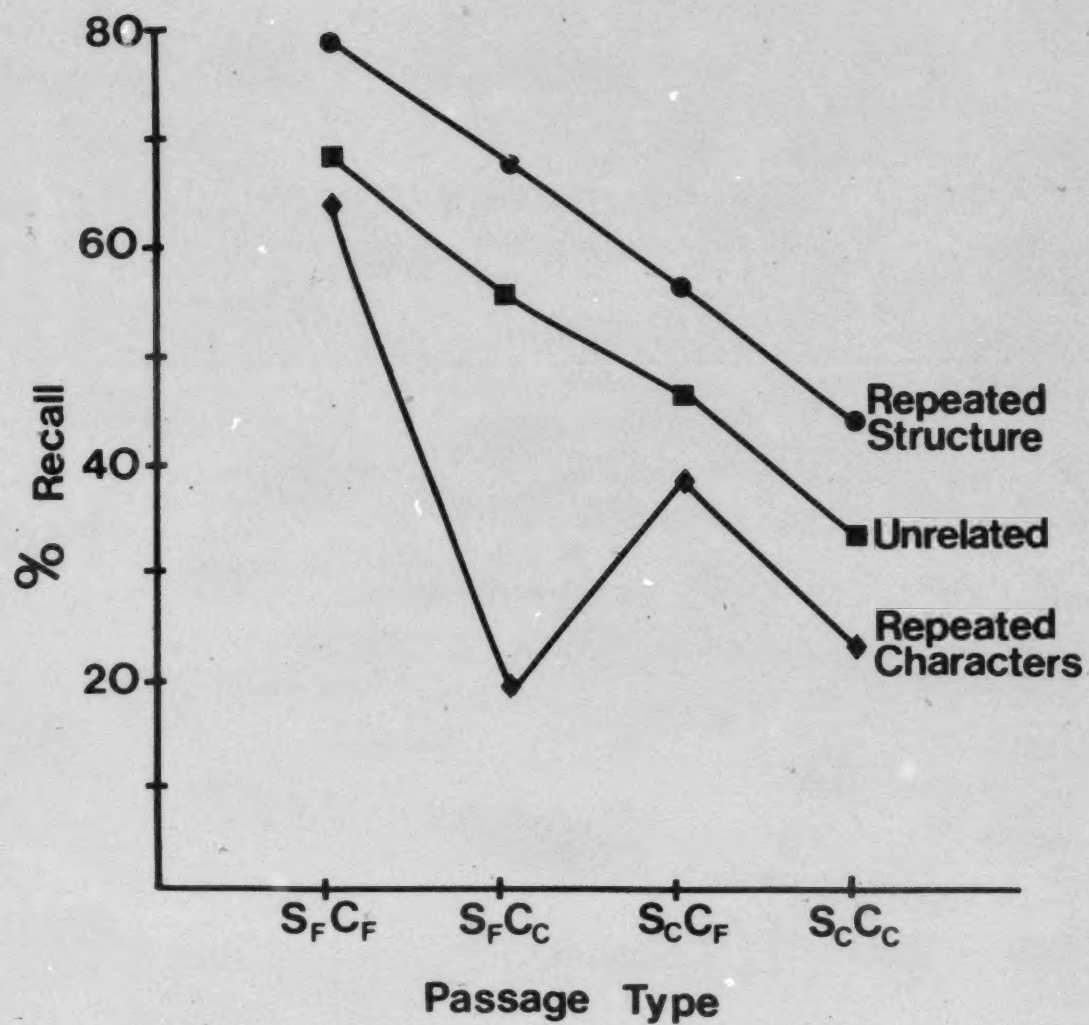


Figure 16. Mean recall proportions for the stories and relatedness conditions of Experiment III.

variable, in six out of the six pairs the stories using the Old Farmer characters were recalled better than the corresponding stories using the Circle Island characters. These differences due to characters was reliable, $F(1,36) = 20.10$, $p < .01$.

The three lines in Figure 16 represent the recall proportions of the four stories as a function of the relatedness of the first and second stories presented. Overall, the mean recall of all four stories when the first story was unrelated (i.e., had different Structure and Characters) was 51%. This mean is broken down into proportions for each story type in the middle line of Figure 16. When the second story presented repeated the structure of the first story, the mean recall level overall was 62%. This mean is a composite of the four points in the top line of Figure 16. When the second story presented to subjects repeated the same character set, the overall recall level was 37%. This condition is represented in the bottom line of Figure 16. It may be noted that when the story structure was repeated recall improved over the unrelated condition for all stories. Similarly, when the character set was repeated in the second story, recall was worse than in the unrelated condition for all four stories. This effect due to the relatedness variable was highly reliable, $F(2,36) = 11.26$, $p < .01$. Newman-Keuls' tests declared both the overall means for Repeated Structure and Repeated Characters to differ reliably from the mean for Unrelated stories ($p < .05$, for both).

Discussion

The results presented here suggest that both structure and content play an important role in memory for stories. The rated comprehensibility of stories was found to be solely a function of structural complexity. When the plot structure was made simple through the use of repetition and redundancy, the stories were rated as easy to comprehend. A more densely structured plot with no repetition produced lower comprehensibility ratings. Story Imagery, on the other hand, appears to be strictly a function of content as defined by the story characters and the particular actions they perform. However, rated imagery was unaffected by structural complexity of the stories. Both comprehensibility and imagery ratings were significantly correlated with recall, and, insofar as the two variables reflect metrics of structural complexity and content concreteness, indicate the influence of structure and content components in memory for stories.

As direct evidence for the independent influence of structure and content on recall of stories, both these variables were significant sources of variance in recall of both first- and second-presented stories. As expected, recall was best when the plot structure was that taken from the Old Farmer story. The relatively high comprehensibility ratings for this case suggest that subjects could readily produce the required plot frame for the story and use it to encode the events of the story. When the Circle Island structure was used in the presented stories, the reduced comprehensibility ratings indicate that subjects found it more difficult to produce the integrating framework for the story plot. This difficulty in identifying the appropriate organizing

frames was directly reflected in the decreased recall proportions relative to those stories using the Old Farmer structure.

Similarly, rated imagery of the stories was found to exert a significant influence on recall. In the context of this experiment, the "Imagery" variable referred to several characteristics of story content. The concreteness of the specific characters in the stories was varied by using either the highly-concrete, imaginable, and familiar Old Farmer characters (an Old Farmer, donkey, dog, cat, and cow) or the more abstract and less familiar Circle Island characters, which were concepts representing various institutional collectives (the Populists, the Federalists, the Senate, a scientist, and a union). The actions performed by the Old Farmer characters were concrete and highly imaginable: the dog barking, the cow giving milk, and so on. The actions of the Circle Island characters, on the other hand, were abstract in that they dealt with complex political maneuvers among the story's characters, the comprehension of which involved extensive abstract knowledge about the political dynamics of democratic governments. Furthermore, the actions of the Old Farmer characters were those typically associated with the animals who perform them, and hence were easily imaginable in association with the animals. So, for example, it is relatively simple to imagine a cow giving milk or eating hay. This stereotypy was not present with the Circle Island characters, whose actions were those of political factions performing abstract actions for the achievements of specific goals. While the observed effect of character set on recall was found to correlate well with imagery, it might be argued that the effect was due not to imagery but to the extreme familiarity of subjects

with the Old Farmer animals and their highly-associated actions, which produced positive transfer in the learning of the stories in which they appeared. The obtained meaningfulness ratings for stories represented an attempt to assess this effect of familiarity. Subjects were instructed to rate the "meaningfulness" of each presented story according to how familiar the characters and their actions were to them, and to what extent the narrative was similar to or consistent with incidents they knew or had read about previously. The mean ratings thus obtained showed no differences in meaningfulness due to the two different character sets. Thus, insofar as meaningfulness ratings may be taken as a measure of extra-experimental familiarity, it appears that a familiarity explanation cannot account for the obtained differences in recall due to character sets.

While structure and content of stories significantly influenced recall of both first- and second-presented stories, transfer effects between the two stories were obtained only for recall of the second story. First-story delayed recall levels were unaffected by whether the immediately-presented second story repeated structure, characters, or was unrelated. Thus there was no retroactive interference or facilitation of first-story delayed recall due to relatedness of the two stories.

In second-story recall, however, the relationship of the first-presented story to the second had a marked effect on recall. When the story structure was repeated in both stories, recall of the second story was significantly improved relative to the control condition in which the two stories were unrelated. This was true despite the fact

that the setting, characters, and specific events in the passages were unrelated and non-overlapping in the two stories. This improvement in recall was obtained for each of the four stories used as stimuli in the experiment. These results suggest that a priming effect or proactive facilitation occurred when the same structure was repeated in both stories. During learning of the first story, the events were comprehended and encoded in terms of the abstract framework incorporating the goals of the main character, the attempts to achieve those goals, the outcomes of the attempts, and the ultimate resolution of the story theme. The frames for these structural relationships are context-free in the sense that the relationships are independent of any particular set of characters or actions. When the first-presented story had been comprehended, a set of the frames had been organized into a structure corresponding to the structural relationships presented in the passage. When the second story was presented, subjects became aware at some point during comprehension that the structures of the two stories was related. (Most subjects in this condition reported during post-experimental debriefing that they had noticed that the two stories had the same "idea," "theme," or "plot.") When recognition of the structural similarity occurred, subjects could then use the same structure which had been formed during first-story comprehension for second-story comprehension. This ability to use an already-existing organization would then facilitate the learning process relative to the case in which an entirely new structure would have to be formed.

In contrast to the results for repeated structure, the repetition of characters in the two stories produced proactive interference.

Story 2 recall was worse for all four passages when the character set was common to both presented stories than when the two passages were unrelated. The nature of the interfering effects for repeated characters seemed to focus on subjects' inability to discriminate in which story a particular action or subject of actions among the characters occurred. During first-story comprehension a framework was formed which encoded the relationship and actions among the characters in a particular plot sentence. When these same characters were engaged in a different set of actions and relationships in the second story, a new set of structures encoding the relationships had to be constructed in memory. Over time the ability to maintain the discriminability of actions and contexts decreased, especially since no intentional learning instructions were given and thus rehearsal is assumed to be minimal. This interference is assumed to lead to a breakdown of the organizing structure for the two plot sequences, and hence a breakdown in the organization among propositions from the original passages. When recall was required on a delayed test, then, the subject was unable to use effectively the organizing frames to recall the individual propositions from the original texts. One subject in this condition experienced such strong interference effects that 50% of the propositions recalled during first-story recall were intrusions from the second story, and the subject could not remember a single proposition from the second story when asked for Story 2 recall. While this extreme case was the exception rather than the rule, it demonstrates the phenomenon of confusion between passages in the condition. The more typical recall protocol of a story in this condition contained many fewer intrusions from

the other story (less than 10% for all subjects in this condition). Rather, the effects of interference due to character repetition seemed to occur at the more general level of abstracting structural characteristics of the plot during second-story presentation. The goal structures and character relationships established during first-story presentation prevented the easy reassignments by subjects of these characters to roles in a second plot sequence. Hence second-story recalls were often more rambling and disorganized with respect to the plot structure than first-story recalls, and only rarely punctuated by intrusions of propositions from the first story. Since this interference effect was obtained only for second-presented stories and not for first-presented stories, it appears that the effect is operative during storage and learning, and not at the retrieval or output stage. If the latter were the case, it would be expected that the interference effect would be observable in reduced recall of both stories.

It should be noted that the proactive interference effect obtained here is expected only in those cases in which subsequent passages utilized entirely different plot sequences, requiring the reassignment of character roles and relationships in each new story context. This condition may be contrasted with a case in which subsequent passages are in some sense "continuations" of each other; that is, subsequent passages elaborate the same theme or present new problems to be solved within the same context or character roles and relationships. If this were the case, it would be expected that positive transfer due to characters would occur, and second-story recall would improve relative to a control condition with two unrelated stories.

CHAPTER 7
EXPERIMENT IV

One aspect of the process of story comprehension which has been implicitly assumed thus far but not addressed directly is the process of drawing inferences from text. The comprehension model which has been proposed here assumes that as people read stories they abstract from incoming propositions linguistic and structural features that they use to encode the propositions into an organizational framework. The ability to extract the relevant information and make the proper inferences depends on a wide variety of stored information, including knowledge about the world, the laws of physics, causality, conventions of plot construction, and author-reader conventions employed in narrative discourse [e.g., conversational postulates (Grice, 1967), presupposition-implication conventions (Just & Clark, 1973), and the Given-New contract (Haviland & Clark, 1974)].

Much research has been conducted in an attempt to characterize the processes involved in performing specific types of inferencing, including intra- and inter-sentential nominal and pronominal reference (Charniak, 1973), verb-based conceptual inferences (Schank, 1972; Schank, 1973; Rieger, 1974), and local relational inferences based on laws of spatial relations and physical laws of the universe (Bransford & Franks, 1971; Bransford, Barclay, & Franks, 1972). The types of inference primarily dealt with in the comprehension model for Experiments I and II are those connecting temporally separated events of a story by positing causal relations among events or underlying character purpose

and intent in the performance of actions. It is through the use of these types of inferences that people identify the structural units of a plot sequence and hence build an organizational frame for the story.

It is hypothesized that during the comprehension of stories, these higher-level relational inferences among events occur in two ways.

First, the comprehension of a particular event in isolation from other events in the story requires the identification of the appropriate prototype frame or situational context for that event. This allows the assignment of particular sentential elements to appropriate slots in the frame, provides default assignments and contexts from the prototype when specific information is missing in the currently-processed event, and generates plausible inferences as part of a scenario or expectation against which subsequently occurring events may be matched. This instantiation of a prototypical frame is analogous to the creation of a token node with pointer to the appropriate type node which is presumed to occur for concepts in propositional memory models (e.g., Anderson & Bower, 1973). For example, the sentence

- (1) John gave Mary the book.

would cause the creation of a new "transfer" frame, with John as the donor, Mary as the recipient, and the book as the object. A plausible inference generated by this frame might be that "John didn't have the book any more." However, the sentence

- (2) John gave Mary the lesson.

would produce during comprehension the creation of an entirely different "teaching" frame, for which the inference "John didn't have the lesson any more" would not apply. That is, (1) and (2) differ not just

in the object position, but they refer to completely different actions with different sets of related inferences. Hence the initial selection of the proper event frame determines which inferences may be plausibly generated for the event.

The second way in which inferences may be generated arises when an incoming event cannot be mapped into any of the currently active frames; that is, the current event does not fit into the expected context. When this occurs inferences are generated from the current event backwards in an attempt to establish an inferential chain between an earlier frame and the current event. This general process of backward inferencing has been referred to as "bridging" (Clark, 1975). If this inferential chain can be established, the current event can be mapped into an appropriate context, or a higher-order structural frame incorporating the current and previous event and their inferences may be instantiated. For example, consider the sequence

(3) John came into the room.

(4) The chandelier was beautiful.

Clearly, an expectancy for chandeliers did not result from the comprehension of (3). When (4) is encountered, it is necessary to find an inference chain relating the two sentences. The shortest and most plausible chain would be something like: "John came into the room. The room contained a chandelier. John saw the chandelier. The chandelier was beautiful."

A simple process model for the comprehension of an event within a story is given in Figure 17. When a new event is input, a set of plausible inferences from that event are generated. The actual number of

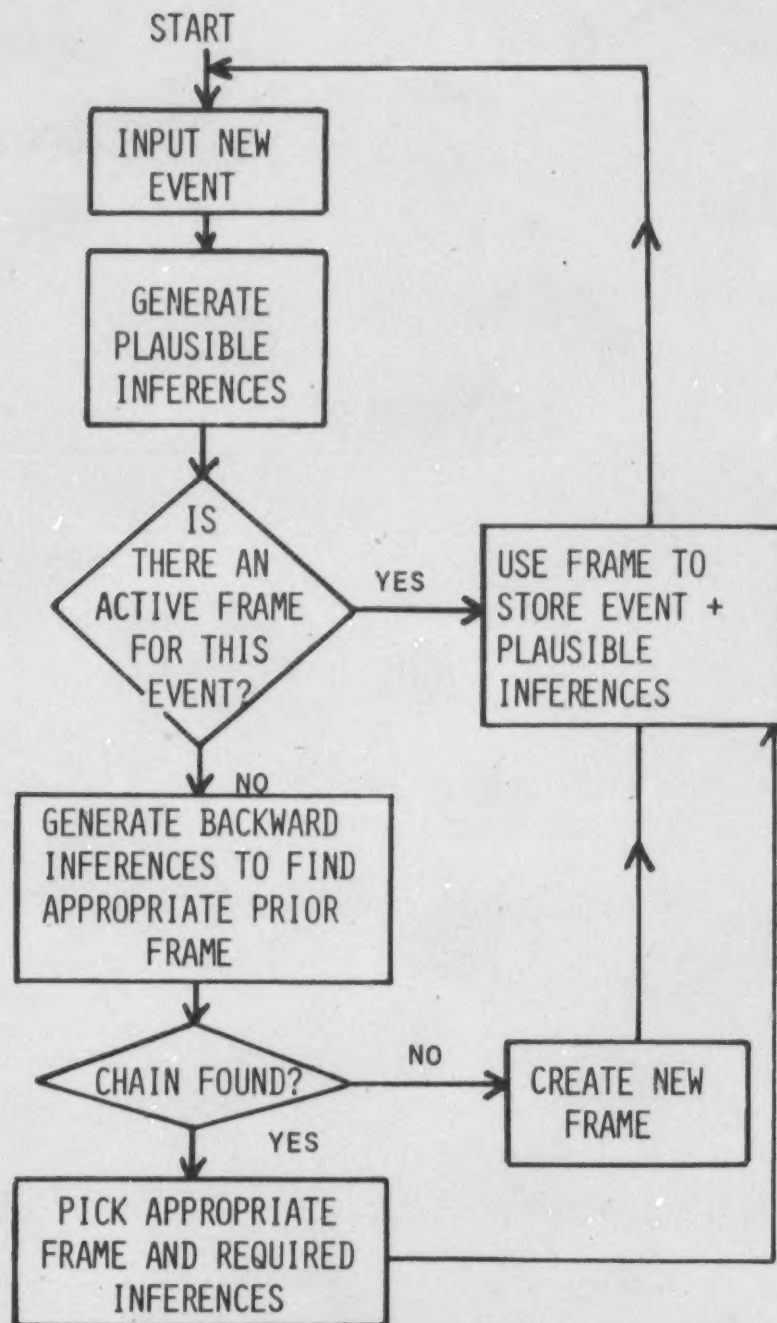


Figure 17. A simple process model for the generation of inferences during story comprehension.

inferences generated depends on such factors as presentation rate of the story, the complexity of the material, the instructions given to the subject for processing the material, and the subject's perceived purpose in reading the story. If there is a currently active frame or context into which the event can be mapped, it is stored with its inferences, and a new event is input. Otherwise, backward inferencing is initiated in order to establish a path to a previous frame for a situation or proposition. If no path is found, the current event will be stored without benefit of an organizational context, perhaps with a special tag or label identifying it as a peculiar out-of-context event. The probability that this event can be later retrieved would be expected to be low due to the fact that no inferential pathway to another event or higher-order context is associated with it for use as a retrieval cue. An exception to this expectation of low retrieval probability would occur if only one or a few events were marked as "peculiar" in an otherwise coherent context. In this case, the oddity of the misfitting event might introduce a salience to the out-of-place event that would increase recall probability. If, on the other hand, virtually all events in the input text were comprehended without benefit of context or organizing framework, the overall proportion of text recall would be expected to be poor. This is the process that is presumed to account for subjects' poor performance on recall of DESCRIPTION passages or randomly-ordered passages in Experiment II.

If an inferential chain can be established between the current event and a previous frame, the current frame and the inferential chain are stored as part of a higher-order structural unit incorporating the

two events and their relational inferences.

Let us consider the way in which the occurrence of an event can influence the plausibility of the inferences stored with a previously-learned event. If an event depends for comprehension on a prior event and a particular one of its inferences generated at the time of input of the prior event, then the plausibility and probable validity of the stored inference would be increased. On the other hand, if the second event can be readily associated with the prior event through a chain which suggests the inappropriateness or implausibility of a particular inference associated with the first event, then that inappropriate inference may be removed from the frame associated with that event. Finally, if the second event is unrelated to a particular inference from the first event, then the occurrence of the second event should not affect the perceived plausibility of the inference.

For example, consider a story containing the sentence

- (5) The hamburger chain owner was afraid his love for
his french fries would ruin his marriage.

In comprehending (5), one might reasonably draw the following inferences:

- (6) The hamburger chain owner got his french fries for free.
(7) The hamburger chain owner's wife didn't like french fries.
(8) The hamburger chain owner was very fat.

These inferences might be stored with the frame representing (5) since they are all somewhat suggested by (5). Since (7) and (8) both refer to possible reasons why the hamburger chain owner's marriage is rocky, it is probable that only one of them is actually the correct inference.

This follows from the assumption that in simple stories the author does not intend ambiguity, and that there is a simple reason for everything. However, there is not sufficient information in (5) to distinguish the relative plausibilities of (7) and (8). Later in the story the following sentence occurs:

- (9) The hamburger chain owner decided to join weight-watchers in order to save his marriage.

In order to understand (9), the reader would need to build an inference chain back to (5) which included as one of its links inference (8).

That is, the husband was obliged to join weight-watchers to save his marriage not because his wife didn't like fries, but because he was fat and his wife didn't like obesity. Thus the probable validity of (8) becomes reinforced, and (7) reduced in plausibility with respect to (6), which is presumed unaffected by the occurrence of (9).

Suppose on the other hand that the later sentence in the story is not (9) but the following:

- (9') The hamburger chain owner decided to see a marriage counselor in order to save his marriage.

In order for a subject to comprehend this sentence, an inference chain from (5) would be produced in approximately the following way:

- (5) The hamburger chain owner was afraid his love for his french fries would ruin his marriage.
 (10) He wanted to save his marriage.
 (11) He thought a marriage counselor would help save the marriage.

(9') He decided to see a marriage counselor in order to
save his marriage.

Neither (6), (7), nor (8) is required in this inference chain, nor is there any information in (9') to suggest any alteration in their plausibility. Thus it would be expected that the perceived plausibility of (6), (7), and (8) would remain unchanged in the story containing (9').

These assumptions were tested in Experiment IV. Stories were constructed in which target sentences [such as (5) above] were followed later in the story by a "continuation" sentence such as (9) or (9') that depended upon the target sentence plus an inference chain for its comprehension. After presentation of a set of stories, a recognition test was given for sentences from the stories. The data of interest were the false alarm rates for test items. False items consisted of inferences from the target sentences [such as (6), (7), and (8) above] which were equated for plausibility when occurring in stories containing neutral continuation sentences [such as (9')]. For each target-continuation pair of sentences, three inferences were constructed.

The continuation sentence for each target sentence was one of two types. In the control condition, the three inferences were neutral with respect to the continuation sentence. That is, the continuation sentence and its inference chain to the target sentence neither relied on nor disconfirmed the test inferences [e.g., sentence (9') above]. Since the test inferences were all equally plausible, and their plausibility was unaffected by the continuation sentence in the control condition, it was expected that the false alarm rate for all test inferences would be equal.

In the experimental condition, comprehension of the continuation sentence required the use of the target sentence and one of the test inferences (designated as the Appropriate inference). Given the continuation sentence and its presumed inference chain to the target sentence, one of the three test inferences would be inappropriate and thus reduced in plausibility (the Inappropriate inference). The third of the three inferences would be neutral with respect to the continuation sentence (referred to hereafter as the Neutral inference). Hence the neutral inference was equally plausible for both types of continuation sentences. For the example given above, (9) was the continuation sentence in the experimental condition. Sentence (8) would then be the Appropriate inference, (7) the Inappropriate inference, and (6) the Neutral inference.

It was expected that reinforcing the Appropriate inference with the experimental continuation sentence would result in the storage of that inference in memory with the target and continuation events. The opportunity for generating and storing the Appropriate inference could thus arise twice: during comprehension of the target sentence, and in building the backward inference chain from the continuation sentence to the target sentence. In contrast, the single opportunity for generating Neutral inferences would arise during comprehension of the target sentence, while the continuation sentence was unrelated to these inferences and hence would not activate them. If this was the case, then it would be expected that the false alarm rate for Appropriate inferences would be higher than for the Neutral inferences. Similarly, the loss of plausibility for the Inappropriate inferences by the continuation sentences

would result in a lower false alarm rate for test items of this type than for the Neutral inferences.

Method

Subjects

Subjects were 48 Stanford undergraduates who participated in the one-hour session for either \$2.00 pay or to satisfy a course requirement.

Materials

Four unrelated stories which had a mean length of 20 sentences were constructed for use in Experiment IV. Each story included two target-continuation pairs of sentences embedded in the text. Each story had two versions, one with the control continuation sentences and one with the experimental continuation sentences.

To insure that the production frequency and appropriateness of the inferences were as postulated, normative productions and plausibility ratings for inferences were obtained for all target-continuation sentence pairs used in the experiment. Twenty-four subjects, different from those participating in the actual experiment, were used for the collection of norms. Each subject received copies of either the four experimental or four control stories. Each story was printed on a separate sheet of paper, with four slashes (/) inserted into the text. The slashes were located at the end of each target and continuation sentence (two of each per story). Subjects were instructed to read the passage up to a delimiting slash, then to write down a set of inferences which might reasonably be drawn from the information in the story

up to that point. Subjects were not restricted as to the type of inference which was allowable; they were told only to generate statements which were likely to be true but which were not explicitly stated in the story. Subjects were allowed unlimited time to produce these inferences. When this had been done, the subject continued reading the passage until the occurrence of the next slash, and the inferencing procedure was repeated. In this manner a set of productions was obtained for each target and continuation sentence used in the experiment. Since the passages included other information than the specific target-continuation pairs of experimental interest, many of the obtained inferences did not pertain to the inference chain connecting the target and continuation sentences. What was of interest was the relative frequency of productions of the specific inferences which were to be used subsequently in the recognition experiment.

When a subject had provided productions for all four stories, he was given a sheet containing a set of specific inferences about the stories and instructed to rate the plausibility of each statement with respect to the story in which it occurred. A 1 (low) to 7 (high) rating scale was used: 1 indicated a highly implausible or false statement; 7 indicated a very plausible or probably true statement. The items on this rating task were the set of test inferences used in the subsequent experiment. It was important to determine that inferences which were theoretically designated as Appropriate, Neutral, or Inappropriate for Experimental subjects would be correspondingly judged as high, medium, or low plausible by subjects.

The collected norms are summarized in Table 5. For each inference

Table 5

Production Frequencies and Plausibility Ratings for the Inferences
Used in Experiment IV

	INFERENCE TYPE			
	<u>Inappropriate</u>	<u>Neutral</u>	<u>Appropriate</u>	<u>Mean</u>
<u>PRODUCTION FREQUENCY</u> (Mean Proportion)				
<u>CONTROL</u>				
After-Target	.32	.30	.30	.31
After-Continuation	.08	.14	.10	.11
TOTAL	.40	.44	.40	.42
<u>EXPERIMENTAL</u>				
After-Target	.33	.34	.38	.35
After-Continuation	.00	.10	.22	.11
TOTAL	.33	.44	.60	.46
<u>PLAUSIBILITY RATINGS</u> (Mean Rating)				
<u>CONTROL</u>	4.60	4.87	4.65	
<u>EXPERIMENTAL</u>	1.88	5.07	6.59	

type, mean production probabilities and plausibility ratings were computed across subjects and stories. The "Inappropriate" and "Appropriate" labels of inference type apply to the Experimental subjects, who received continuation sentences which differentially reinforced these inferences. It was hoped that for control subjects all such inferences would be rated as "Neutral."

For the production norms, mean production probabilities of inferences designated as Appropriate, Neutral, and Inappropriate are given for the after-target and after-continuation locations in the passage. Since the control and experimental stories differed only in the continuation sentences, it was expected that production probabilities would be equivalent for the after-target productions for Control and Experimental stories. Furthermore, since appropriateness of the inferences was determined by the continuation sentence, no differences were expected among inference types at the after-target location. These expectations were confirmed: the mean production probability of inferences of experimental interest at the after-target position in the stories was .31 for the Control stories, and .35 for the Experimental stories. In addition, there were no differences in these probabilities across inference type, all individual means falling within the range of .30 to .38.

For the after-continuation productions, it was expected that inference type would have an effect in only the Experimental passage, reinforcing the Appropriate inference and disconfirming the Inappropriate inferences. This prediction was confirmed: for the Control stories no differences in mean production probability was obtained at the after-

continuation location, but a large effect in the expected direction was obtained for the Experimental stories. Across both story positions, then, the three inference types were equally likely to be produced for the Control stories (.40 vs. .44 vs. .40), while for the experimental stories inference type produced large differences in production probability (.33 for Inappropriate, .44 for Neutral, .60 for Appropriate). As expected, the Neutral inferences were not differentially affected by passage type (.44 for both Experimental and Control passages).

Since the plausibility ratings were obtained for the test inferences after reading of the passages was completed, it was expected that in the Experimental condition plausibility ratings would be increased for the Appropriate inferences relative to the Control condition and relative to the Neutral inferences in the Experimental condition. Similarly, it was expected that the Inappropriate inferences in the Experimental condition would receive low plausibility ratings relative to these same inferences in the Control condition and relative to the Neutral inferences in the Experimental condition. It may be noted from Table 5 that each of these predictions was confirmed. In the control condition, there were no differences in the plausibility ratings among the three inference types. For the experimental passages, the Appropriate inferences received the highest plausibility rating (6.59), the Inappropriate inferences the lowest ratings (1.88). The Neutral inferences, with a mean of 5.07, were nearly identical to the same inferences in the control condition (4.87).

Design and Procedure

A between-subject design was used. Subjects were assigned randomly to either the control or experimental condition. They were tested in groups ranging in size from one to four persons.

An incidental learning procedure was used. Subjects received copies of the four stories, one per page. They were instructed to read a story through once at normal reading speed, then turn the page down and rate the story on three dimensions: comprehensibility, imagery, and meaningfulness. Instructions for the ratings were identical to those used in Experiment III. After the ratings had been completed, the subject went on to the next story. The procedure was repeated until all four stories had been read and rated. A Latin-square design was used to counterbalance the presentation order of stories across subjects.

After all the stories had been read, a recognition memory test was given for sentences from the story. A separate block of test items was given for each story, in the same order in which the stories had been read. The Experimenter read a set of sentences aloud to the subjects. For each sentence, subjects responded "yes" if they thought the sentence had been explicitly presented in the story, and "no" if they thought the sentence was not presented explicitly in the story but represented instead an inference about the story. Responses were written by subjects on individual response sheets. The recognition test for each story contained 12 items: six true sentences from the story, and two sets of three "false" items, each set representing the set of inferences for the two target-continuation sentence pairs in the story.

The order of test item presentation was randomly determined for each experimental session.

Results

The mean false alarm rates for the various inference types are summarized in Figure 18. Reliability tests were performed on the experimental effects using an analysis of variance that treated both subjects and inferences as random effects (see Clark, 1973). The overall hit rates and false alarm rates for the two experimental groups were equivalent. The probability of correct recognition of a sentence from one of the stories was .859 for the Control group and .844 for the Experimental group. Similarly, the mean probability of a false alarm to an inference not explicitly stated in the story was .253 for the Control group and .347 for the Experimental group. The difference in false alarms due to treatment group was not significant, $\min F'(1,62) = 3.20, p > .05$.

As predicted, inference type had a marked effect on false alarm rates. For the Experimental group, the probability of a false alarm was highest for Appropriate inferences at .583, .401 for Neutral inferences, and lowest for Inappropriate inferences at .057. For the Control group, false alarm rates were nearly equal for the three inference types: .214 for Appropriate, .307 for Neutral, and .224 for Inappropriate inferences. Due to the large differences obtained in the Experimental Condition, the main effect of inference type was reliable, $\min F'(2,33) = 9.56, p < .01$. As predicted, the interaction between treatment group and inference type was highly reliable, $\min F'(2,56) =$

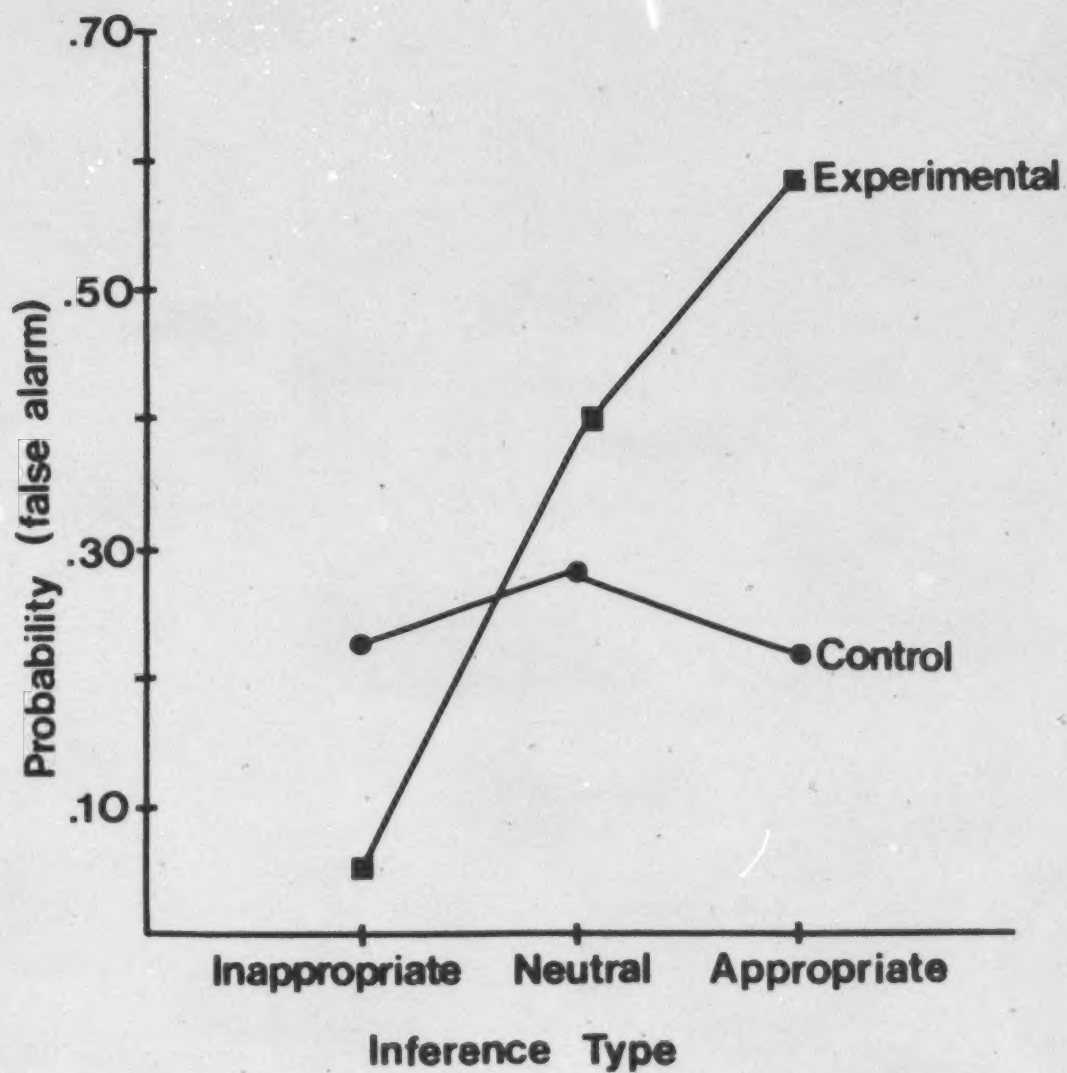


Figure 18. Mean false alarm rates for the inferences in Experiment IV.

17.83, $p < .001$. For the experimental group, Newman-Keuls tests declared the pair-wise differences between Appropriate and Neutral inferences and between Neutral and Inappropriate inferences to be significant ($p < .01$ for both). As expected, the difference in false alarm rates for Neutral inferences between the Control and Experimental conditions (.106) did not differ reliably, $t(46) = 1.36$, $p > .05$.

Discussion

The results presented here suggest that the generation and storage of inferences plays an important role in the comprehension of prose passages. It has been argued that prose comprehension consists not only of comprehension of individual sentences, but of the integration of these sentences into a larger framework incorporating implicit causal, temporal, and motivational information. The primary function of the inferential process is to generate from explicitly-given information new propositions that permit the interrelation of these propositions into a more general situation or frame. According to the model proposed here, the reader takes in a sentence and attempts to integrate it into memory by identifying the event with a currently active frame established previously in the passage. If there is no currently active or unfilled frame, or if the sentence does not fit it, inferences are generated backwards from the current sentence in an attempt to establish a connection with an earlier situation or event. In either case, the sentence is stored in an integrated structure with its necessary associated inferences.

This model leads to important predictions about the comprehension

of prose passages in an experimental setting. When a subject reads a prose passage for comprehension, he establishes situational frames or contexts as part of the comprehension process. These frames provide expectations for subsequent information against which new incoming sentences can be matched. When an incoming sentence is predicted by or consistent with a current context, the comprehension of the sentence should occur rapidly since it can be directly incorporated into the current context. When no currently active frame is available to aid comprehension, the subject must initiate backward inferences to a previous frame or context, which should be a more time-consuming process. Haviland and Clark (1974) obtained this result using comprehension latencies for sentences. They found that preceding a target sentence with a sentence which explicitly stated the assumed or "given" information in the target sentence speeded comprehension time of the target sentence relative to a priming sentence which supplied more vague and general context information.

This view of comprehension as a process of integrating new sentences with antecedent information in extra-sentential organizational structures is somewhat different from that taken in the implementation of many recent network models of memory (e.g., Rumelhart, Lindsay, & Norman, 1972; Anderson & Bower, 1973). In these models each sentence is treated more or less as an independent event, and the integration of new information with old occurs only to establish referential links between individual concepts and previously-occurring appearances of the same concepts. In contrast, the view taken here is that information from incoming propositions is clustered together in organizational

frames and situational contexts, integrated by plausible inferences that give the text coherence and continuity. What is stored in memory, then, is a structure encoding the situation described by a series of related propositions and their requisite inferences. Within such an organizing frame the inferences generated in the integration process may become indistinguishable from those propositions that were explicitly stated. Several researchers have demonstrated that, for certain inference types, this integration process leads to recognition confusions between what was stated and what was inferred. Bransford and Franks (1971) presented subjects with a number of sentences derived from sets of four propositions (for example, The rock rolled down the mountain; The hut was tiny; The rock crushed the hut; and The hut was at the edge of the woods). The presented sentences contained from one to three (but never four) of these sentences in various combinations. On a later recognition task subjects claimed with high confidence that the sentence containing all four propositions (for example, The rock which rolled down the mountain crushed the tiny hut at the edge of the woods) had been originally presented. In establishing referential connections between the same concepts appearing in different sentences (i.e., the rock and the hut), subjects integrated the information together in a structure which encoded the entire situation but which failed to differentiate among the originally presented sentences. Similarly, Bransford, Barclay, and Franks (1972) found that this process of situational integration led to recognition confusions in subjects' memory for previously-presented spatial relations.

The results obtained in Experiment IV extend and generalize these

earlier results in several important ways. The target-continuation sentence pairs that focused on the inferences of interest were embedded in coherent narrative passages. Subjects read the passages for comprehension and were not aware that a recognition test would be administered later. The use of this procedure and material set represented an attempt to duplicate the processing environment in which people normally read, comprehend, and integrate information. The results reported here argue that the obtained recognition confusions are a direct reflection of this integration process and not an artifact of the experimental procedure.

Since simple narrative stories were used as stimulus materials in this experiment, subjects' story comprehension depended on the generation of numerous inferences of various types. The few of these inferences tested in Experiment IV were controlled for production frequency and plausibility. These measures were assumed to reflect a baseline probability of the inclusion of these inferences in the situational representation of the stories. In the experimental condition, the comprehension of the continuation sentences forced utilization of selected inferences in forming a bridging structure to previous information. The prediction that this priming or reinforcing process should result in an increase in false recognition rates for these inferences was confirmed by the data. This priming procedure was useful in that it could be used to selectively boost the salience and appropriateness of particular inferences while leaving others unaffected. The use of this procedure enjoys the advantages over earlier studies of not being confined to the testing of recognition confusions for inferences of any

particular type. Instead, inferences of any type may be tested as long as a baseline measure of their plausibility in the experimental context can be ascertained and controlled. In the present experiment inferences of several types were tested, including verb presupposition and implication (see Just & Clark, 1973), inferred result, inferred instrument, inferred antecedent condition, and inferences based on world knowledge. The pattern of results reported here seems to imply that inference type is an unimportant variable in predicting false alarm rates; rather, recognition confusions depend on the integrating ability of the individual inference for a required comprehension context.

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APPENDIX I

Passages Used in Experiment I

- a. STORY
- b. NARRATIVE-AFTER THEME
- c. NARRATIVE-NO THEME
- d. RANDOM

APPENDIX Ia

The Old Farmer and His Stubborn Animals

STORY

(1) There was once an old farmer (2) who owned a very stubborn donkey. (3) One evening the farmer was trying to put his donkey into its shed. (4) First, the farmer pulled the donkey, (5) but the donkey wouldn't move. (6) Then the farmer pushed the donkey, (7) but still the donkey wouldn't move. (8) Finally, the farmer asked his dog (9) to bark loudly at the donkey (10) and thereby frighten him into the shed. (11) But the dog refused. (12) So then, the farmer asked his cat (13) to scratch the dog (14) so the dog would bark loudly (15) and thereby frighten the donkey into the shed. (16) But the cat replied, "I would gladly scratch the dog (17) if only you would get me some milk." (18) So the farmer went to his cow (19) and asked for some milk (20) to give to the cat. (21) But the cow replied, (22) "I would gladly give you some milk (23) if only you would give me some hay." (24) Thus, the farmer went to the haystack (25) and got some hay. (26) As soon as he gave the hay to the cow, (27) the cow gave the farmer some milk. (28) Then the farmer went to the cat (29) and gave the milk to the cat. (30) As soon as the cat got the milk, (31) it began to scratch the dog. (32) As soon as the cat scratched the dog, (33) the dog began to bark loudly. (34) The barking so frightened the donkey (35) that it jumped immediately into its shed.

APPENDIX Ib

The Old Farmer and His Stubborn Animals

NARRATIVE-AFTER THEME

There was once an old farmer who owned some very stubborn animals. One evening the farmer was taking a walk, when he saw his donkey. The farmer pulled the donkey, but the donkey didn't move. Then he pushed the donkey, but still the donkey didn't move. Then the farmer went to his cow and asked for some milk. But the cow replied, "I would rather have you give me some hay to eat." Then the farmer saw his dog, and he asked him to bark loudly. But the dog refused. Then the farmer went to the haystack and got some hay. When he gave the hay to the cow, the cow gave the farmer some milk. Then the farmer asked his cat to scratch the dog. But the cat replied, "I am thirsty and would be happy if you would get me some milk." So the farmer gave his milk to the cat. As soon as the cat got the milk it began to scratch the dog. As soon as the cat scratched the dog, the dog began to bark loudly. The barking so frightened the donkey that it jumped immediately into its shed, which is precisely what the farmer had been trying to get the donkey to do from the beginning.

APPENDIX Ic

The Old Farmer and His Stubborn Animals

NARRATIVE-NO THEME

There was once an old farmer who owned some very stubborn animals. One evening the farmer was taking a walk, when he saw his donkey. The farmer pulled the donkey, but the donkey didn't move. Then he pushed the donkey, but still the donkey didn't move. Then the farmer went to his cow and asked for some milk. But the cow replied, "I would rather have you give me some hay to eat." Then the farmer saw his dog, and he asked him to bark loudly. But the dog refused. Then the farmer went to the haystack and got some hay. When he gave the hay to the cow, the cow gave the farmer some milk. Then the farmer asked his cat to scratch the dog. But the cat replied, "I am thirsty and would be happy if you would get me some milk." So the farmer gave his milk to the cat. As soon as the cat got the milk, it began to scratch the dog. As soon as the cat scratched the dog, the dog began to bark loudly. The barking so frightened the donkey that it jumped immediately into its shed, which the farmer had built at the time he had purchased the donkey.

APPENDIX Id

The Old Farmer and His Stubborn Animals

RANDOM

Thus, the farmer went to the haystack and got some hay. First, the farmer pulled the donkey, but the donkey wouldn't move. As soon as the cat got the milk it began to scratch the dog. The barking so frightened the donkey that it jumped immediately into its shed. One evening the farmer was trying to put his donkey into its shed. But the cow replied, "I would gladly give you some milk if only you would give me some hay." Finally, the farmer asked his dog to bark loudly at the donkey and thereby frighten him into the shed. There was once an old farmer who owned a very stubborn donkey. As soon as he gave the hay to the cow, the cow gave the farmer some milk. As soon as the cat scratched the dog, the dog began to bark loudly. But the dog refused. But the cat replied, "I would gladly scratch the dog if only you would get me some milk." Then the farmer pushed the donkey, but still the donkey wouldn't move. Then the farmer went to the cat and gave the milk to the cat. So then, the farmer asked his cat to scratch the dog so the dog would bark loudly and thereby frighten the donkey into the shed. So the farmer went to his cow and asked for some milk to give to the cat.

APPENDIX II

Passages Used in Experiment II

- a. Old Farmer: DESCRIPTION-NORMAL
- b. Old Farmer: STORY-RANDOM
- c. Old Farmer: NARRATIVE-AFTER GOAL-RANDOM
- d. Old Farmer: NARRATIVE-NO THEME-RANDOM
- e. Old Farmer: DESCRIPTION-RANDOM
- f. Circle Island: STORY-NORMAL
- g. Circle Island: NARRATIVE-AFTER THEME-NORMAL
- h. Circle Island: NARRATIVE-NO THEME-NORMAL
- i. Circle Island: DESCRIPTION-NORMAL
- j. Circle Island: STORY-RANDOM
- k. Circle Island: NARRATIVE-AFTER THEME-RANDOM
- l. Circle Island: NARRATIVE-NO THEME-RANDOM
- m. Circle Island: DESCRIPTION-RANDOM

APPENDIX IIa

The Old Farmer and His Stubborn Animals

DESCRIPTION-NORMAL

There was once an old farmer who owned some very stubborn animals. In the evenings the farmer would often take walks and watch the activities of his animals. His donkey stood in the barnyard, grazing on some grass. The donkey showed no interest in returning to its shed, where it usually spent the nights. The farmer had built the shed at the time he had purchased the donkey. Neither pushing nor pulling the donkey would coax him into the shed. The farmer's cow wanted its hay. The supply of hay was at the nearby haystack. The farmer would go there daily to get the hay to give to his cow. The pail of milk the cow provided for the farmer was sitting nearby. Each day the farmer went to his cow to collect the milk. The cow never gave milk until it got its hay. The farmer's cat was scratching the dog. The farmer saw his dog, which was barking loudly. The barking of the dog was frightening the donkey, and it was jumping into its shed. The farmer wanted his cat to scratch the dog. The cat was thirsty and wanted to get some milk from the farmer. It began drinking the milk left for the farmer by the cow.

APPENDIX IIb

The Old Farmer and His Stubborn Animals

STORY-RANDOM

Thus, the farmer went to the haystack and got some hay. First, the farmer pulled the donkey, but the donkey wouldn't move. As soon as the cat got the milk, it began to scratch the dog. The barking so frightened the donkey that it jumped immediately into its shed. One evening the farmer was trying to put his donkey into its shed. But the cow replied, "I would gladly give you some milk if only you would give me some hay." Finally, the farmer asked his dog to bark loudly at the donkey and thereby frighten him into the shed. There was once an old farmer who owned a very stubborn donkey. As soon as he gave the hay to the cow, the cow gave the farmer some milk. As soon as the cat scratched the dog, the dog began to bark loudly. But the dog refused. But the cat replied, "I would gladly scratch the dog if only you would get me some milk." Then the farmer pushed the donkey, but still the donkey wouldn't move. Then the farmer went to the cat and gave the milk to the cat. So then, the farmer asked his cat to scratch the dog so the dog would bark loudly and thereby frighten the donkey into the shed. So the farmer went to his cow and asked for some milk to give to the cat.

APPENDIX IIc

The Old Farmer and His Stubborn Animals

NARRATIVE-AFTER THEME-RANDOM

Then the farmer asked his cat to scratch the dog. Then he pushed the donkey, but still the donkey didn't move. As soon as the cat got the milk it began to scratch the dog. The farmer pulled the donkey, but the donkey didn't move. Then the farmer went to the haystack and got some hay. Then the farmer saw his dog, and he asked him to bark loudly. One evening the farmer was taking a walk, when he saw his donkey. But the cat replied, "I am thirsty and would be happy if you would get me some milk." Then the farmer went to his cow and asked for some milk. The barking so frightened the donkey that it jumped immediately into its shed, which is precisely what the farmer had been trying to get the donkey to do from the beginning. There was once an old farmer who owned some very stubborn animals. But the cow replied, "I would rather have you give me some hay to eat." As soon as the cat scratched the dog, the dog began to bark loudly. When he gave the hay to the cow, the cow gave the farmer some milk. But the dog refused. So the farmer gave his milk to the cat.

APPENDIX IIId

The Old Farmer and His Stubborn Animals

NARRATIVE-NO THEME-RANDOM

Then the farmer asked his cat to scratch the dog. Then he pushed the donkey, but still the donkey didn't move. As soon as the cat got the milk it began to scratch the dog. The farmer pulled the donkey, but the donkey didn't move. Then the farmer went to the haystack and got some hay. Then the farmer saw his dog, and he asked him to bark loudly. One evening the farmer was taking a walk, when he saw his donkey. But the cat replied, "I am thirsty and would be happy if you would get me some milk." Then the farmer went to his cow and asked for some milk. The barking so frightened the donkey that it jumped immediately into its shed, which the farmer had built at the time he had purchased the donkey. There was once an old farmer who owned some very stubborn animals. But the cow replied, "I would rather have you give me some hay to eat." As soon as the cat scratched the dog, the dog began to bark loudly. When he gave the hay to the cow, the cow gave the farmer some milk. But the dog refused. So the farmer gave his milk to the cat.

APPENDIX IIe

The Old Farmer and His Stubborn Animals

DESCRIPTION-RANDOM

His donkey stood in the barnyard, grazing on some grass. The farmer would go to the haystack daily to get the hay to give to his cow. The farmer wanted his cat to scratch the dog. The donkey showed no interest in returning to its shed, where it usually spent the nights. The barking of the dog was frightening the donkey, and it was jumping into its shed. The pail of milk the cow provided for the farmer was sitting nearby. In the evenings the farmer would often take walks, and watch the activities of his animals. The cat was thirsty and wanted to get some milk from the farmer. The farmer's cow wanted its hay. The farmer saw his dog, which was barking loudly. The supply of hay was at the nearby haystack. The cow never gave milk until it got its hay. There was once an old farmer who owned some very stubborn animals. The cat began drinking the milk left for the farmer by the cow. Neither pushing nor pulling the donkey would coax him into the shed. The farmer had built the shed at the time he had purchased the donkey. Each day the farmer went to his cow to collect the milk. The farmer's cat was scratching the dog.

APPENDIX II f

Circle Island

STORY-NORMAL

(1) Circle Island is located in the middle of the Atlantic Ocean, (2) north of Ronald Island. (3) The main occupations on the island are farming and ranching. (4) Circle Island has good soil, (5) but few rivers and (6) hence a shortage of water. (7) The island is run democratically. (8) All issues are decided by a majority vote of the islanders. (9) The governing body is a senate, (10) whose job is to carry out the will of the majority. (11) Recently, an island scientist discovered a cheap method (12) of converting salt water into fresh water. (13) As a result, the island farmers wanted (14) to build a canal across the island, (15) so that they could use water from the canal (16) to cultivate the island's central region. (17) Therefore, the farmers formed a pro-canal association (18) and persuaded a few senators (19) to join. (20) The pro-canal association brought the construction idea to a vote. (21) All the islanders voted. (22) The majority voted in favor of construction. (23) The senate, however, decided that (24) the farmers' proposed canal was ecologically unsound. (25) The senators agreed (26) to build a smaller canal (27) that was 2 feet wide and 1 foot deep. (28) After starting construction on the smaller canal, (29) the islanders discovered that (30) no water would flow into it. (31) Thus the project was abandoned. (32) The farmers were angry (33) because of the failure of the canal project. (34) Civil War appeared inevitable.

APPENDIX IIg

Circle Island

NARRATIVE-AFTER THEME-NORMAL

Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. The main occupations on the island are farming and ranching. Circle Island has good soil, but few rivers and hence a shortage of wildlife. The island is run democratically. All issues are decided by a majority vote of the islanders. The governing body is a senate, whose job is to carry out the will of the majority. Recently, an island scientist discovered a cheap method of converting salt water into fresh water. The island farmers formed a co-operative association and persuaded a few senators to join. The co-operative association brought their issues to a vote. All the islanders voted. The majority voted in favor of the association. The senators began to build a small canal that was 2 feet wide and 1 foot deep. After starting construction on the small canal, the islanders discovered that no water would flow into it. The project was abandoned. Civil War appeared inevitable. The farmers were angry because of the failure of the canal project. The island farmers had wanted to build a canal across the island, so that they could use water from the canal to cultivate the island's central region. However, the senate had decided that the farmers' proposed canal was ecologically unsound.

APPENDIX IIh

Circle Island

NARRATIVE-NO THEME-NORMAL

Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. The main occupations on the island are farming and ranching. Circle Island has good soil, but few rivers and hence a shortage of wildlife. The island is run democratically. All issues are decided by a majority vote of the islanders. The governing body is a senate, whose job is to carry out the will of the majority. Recently, an island scientist discovered a cheap method of converting salt water into fresh water. The island farmers formed a co-operative association and persuaded a few senators to join. The co-operative association brought their issues to a vote. All the islanders voted. The majority voted in favor of the association. The senators began to build a small canal that was 2 feet wide and 1 foot deep. After starting construction on the small canal, the islanders discovered that no water would flow into it. The project was abandoned. Civil War appeared inevitable. The farmers were angry because of the failure of the canal project. The island farmers decided to build a colony for themselves, so they migrated inland from their homes to inhabit the island's central region. However, the senate decided the farmers' proposed move was ecologically unsound.

APPENDIX III
Circle Island
DESCRIPTION-NORMAL

Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. The main occupations on the island are farming and ranching. Circle Island has good soil, but few rivers and hence a shortage of wildlife. The island is run democratically. All issues are decided by a majority vote of the islanders. The governing body is a senate, whose job is to carry out the will of the majority. Salt water is converted to fresh water by a cheap method discovered by an island scientist. The island farmers favor building canals across the island. Water from the rivers is used to cultivate the island's central region. A co-operative association formed by the farmers has persuaded a few senators to join. The co-operative association issues are periodically brought to a vote. All the islanders vote. The majority favor the association. The senate is responsible for the construction of a small canal that is 2 feet wide and 1 foot deep. The project was abandoned shortly after construction started on the small canal. The islanders discovered that no water would flow into it. Civil War appears inevitable. The farmers are angry because of the failure of the canal project. The senate believes that the farmers' proposed canal is ecologically unsound.

APPENDIX IIj

Circle Island

STORY-RANDOM

The pro-canal association brought the construction idea to a vote. The governing body is a senate, whose job is to carry out the will of the majority. Thus the project was abandoned. The island is run democratically. All the islanders voted. The farmers were angry because of the failure of the canal project. Recently, an island scientist discovered a cheap method of converting salt water into fresh water. Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. All issues are decided by a majority vote of the islanders. The majority voted in favor of construction. Civil War appeared inevitable. The main occupations on the island are farming and ranching. The senators agreed to build a smaller canal that was 2 feet wide and 1 foot deep. The senate, however, decided that the farmers' proposed canal was ecologically unsound. As a result, the island farmers wanted to build a canal across the island, so that they could use water from the canal to cultivate the island's central region. Circle Island has good soil, but few rivers and hence a shortage of water. After starting construction on the smaller canal, the islanders discovered that no water would flow into it. Therefore, the farmers formed a pro-canal association and persuaded a few senators to join.

APPENDIX IIk

Circle Island

NARRATIVE-AFTER THEME-RANDOM

All issues are decided by a majority vote of the islanders. However, the senate had decided that the farmers' proposed canal was ecologically unsound. The island is run democratically. All the islanders voted. The governing body is a senate, whose job is to carry out the will of the majority. The farmers were angry because of the failure of the canal project. Circle Island has good soil, but few rivers and hence a shortage of wildlife. The majority voted in favor of the association. The island farmers had wanted to build a canal across the island, so that they could use water from the canal to cultivate the island's central region. Recently, an island scientist discovered a cheap method of converting salt water into fresh water. Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. The senators began to build a small canal that was 2 feet wide and 1 foot deep. The island farmers formed a co-operative association and persuaded a few senators to join. The project was abandoned. The main occupations on the island are farming and ranching. After starting construction on the small canal, the islanders discovered that no water would flow into it. The co-operative association brought their issues to a vote. Civil War appeared inevitable.

APPENDIX III

Circle Island

NARRATIVE-NO THEME-RANDOM

All issues are decided by a majority vote of the islanders. However, the senate had decided that the farmers' proposed move was ecologically unsound. The island is run democratically. All the islanders voted. The governing body is a senate, whose job is to carry out the will of the majority. The farmers were angry because of the failure of the canal project. Circle Island has good soil, but few rivers and hence a shortage of wildlife. The majority voted in favor of the association. The island farmers decided to build a colony for themselves, so they migrated inland from their homes to inhabit the island's central region. Recently, an island scientist discovered a cheap method of converting salt water into fresh water. Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. The senators began to build a small canal that was 2 feet wide and 1 foot deep. The island farmers formed a co-operative association and persuaded a few senators to join. The project was abandoned. The main occupations on the island are farming and ranching. After starting construction on the small canal, the islanders discovered that no water would flow into it. The co-operative association brought their issues to a vote. Civil War appeared inevitable.

APPENDIX II

Circle Island

DESCRIPTION-RANDOM

The senate is responsible for the construction of a small canal that is 2 feet wide and 1 foot deep. Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. The governing body is a senate, whose job is to carry out the will of the majority. A co-operative association formed by the farmers has persuaded a few senators to join. The islanders discovered that no water would flow into it. The island is run democratically. Salt water is converted to fresh water by a cheap method discovered by an island scientist. Civil War appears inevitable. The co-operative association issues are periodically brought to a vote. The farmers are angry because of the failure of the canal project. The majority favor the association. Water from the rivers is used to cultivate the island's central region. The senate believes that the farmers' proposed canal is ecologically unsound. The island farmers favor building canals across the island. Circle Island has good soil, but few rivers and hence a shortage of wildlife. All issues are decided by a majority vote of the islanders. The main occupations on the island are farming and ranching. The project was abandoned shortly after construction started on the small canal.

APPENDIX III

Passages Used in Experiment III

a. $S_C^C F$

b. $S_C^C C$

c. $S_F^C C$

APPENDIX IIIa

The Old Farmer and His Stubborn Animals

S_CF

Large dairy farms are located throughout Fleetwood County. Unfortunately, all the farmers in the county are very poor, so their farms are small and usually in great need of repair. One old farmer owned several animals who all lived together in a communal barn. The old farmer cared for his animals and always tried to make their lives on the farm enjoyable. The animals organized themselves into a voting democracy, and resolved barnyard issues by a majority vote. One day the farmer's cow discovered a bag of gold coins hidden beneath a clover patch. So some of the animals decided among themselves that they wanted to build a new barn, since the old one was nearly useless. So, these animals formed a planning committee and persuaded some other animals that the money should be spent to rebuild. A referendum was held on the issue, and all of the animals voted. All of the animals voted in favor of the new barn. The farmer decided that the taxes on a new barn would be too high. The farmer agreed instead to make improvements to the old barn. After remodeling of the old barn was completed, a fire destroyed the entire barn. The farmer would not rebuild again, and the animals were left homeless. The animals were angry because the farmer was such a miser. In retaliation, they burned down his house.

APPENDIX IIIb

Circle Island

 $S_C C_C$

Circle Island is located in the middle of the Atlantic Ocean, north of Ronald Island. The main political factions on the island are the Populists and the Federalists. Circle Island has good soil, but few rivers and hence a shortage of water. The island is run democratically. All issues are decided by a majority vote of the islanders. The governing body is a senate, whose job is to carry out the will of the majority. Recently, an island scientist discovered a cheap method of converting salt water into fresh water. As a result, the Populists wanted to build a canal across the island, so they could use water from the canal to cultivate the island's central region. Therefore, the Populists formed a pro-canal association and persuaded a few senators to join. The pro-canal association brought the construction idea to a vote. All the islanders voted. The majority voted in favor of construction. The senate, however, decided that the Populists' proposed canal was ecologically unsound. The senators agreed to build a smaller canal that was 2 feet wide and 1 foot deep. After starting construction on the smaller canal, the islanders discovered that no water would flow into it. Thus the project was abandoned. The Populists were angry because of the failure of the canal project. Civil War appeared inevitable.

APPENDIX IIIc

Circle Island

S C
F C

Circle Island is governed by a constitutional democracy. The two major political parties are the Populists and the Federalists. Last spring the Federalists promoted a senate bill for the installation of an island-wide communications network to be used in weather prediction. The Federalists petitioned the senate, but the senate would not pass the bill. So the Federalists asked the Populists to join forces in support of the bill and thereby pressure the senate into action. The Populists, however, declined the proposal. Then the Federalists asked the island's independent weathermen's union to announce support of the bill so that Populists would join the Federalists' fight and thereby win passage of the bill in the senate. The union agreed to support the Federalists only if the usefulness of the project could be demonstrated to them. So the Federalists made a plea to a prominent scientist to testify to the technical advantages of the communications network. But the scientist declined to testify until research on the signal transmission properties of the system could be conducted. Thus the Federalists funded scientific research which resulted in proof of the efficiency of the system. As soon as the results were released, the scientist agreed to testify. The scientist testified before the union in support of the installation project. The union was thus convinced and publicly announced their backing of the Federalists. As a result of the union's announced support for the plan, the Populists joined the Federalists to fight for passage of the Bill. The support for the bill was so overwhelming that the senate immediately passed it and signed it into law.